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SCHOOL SCIENCE AND MATHEMATICS

DECEMBER 1953

School Science and Mathematics

A Journal for All Science and Mathematics Teachers

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Contents of previous issues may be found in the Educational Index to Periodicals.

The sky was clear all yesterday,
From dawn until the sunset's flame;
But when the red had grown to gray,
Out of the west the snow clouds came.
. . . .
Here floats no chime of Christmas bell,
There is no voice to give me cheer;
But through the pine wood all is well,
For God and love and peace are here.
—"*Christmas in the Pines.*"
MEREDITH NICHOLSON

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SCHOOL SCIENCE AND MATHEMATICS

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INSTRUCTIONAL MATERIALS FOR CONSUMER SCIENCE

SAM S. BLANC
East High School, Denver 6, Colorado

The study of the protection of the consumer against impure and adulterated foods and drugs may bring about several interesting activities. Labels of packaged foods and patent medicines may be made into exhibits or bulletin board displays. Pupils might be interested in making tables and charts to show the variety of foods and medicines bought at home. On these the proper points to look for on the label may be indicated. Three motion pictures produced by several business concerns explain how packaging of food and other products came about, and how standard labels and protected brand names were developed. These are:

1. *Marks of Merit*	2 reels,	b & w,	MTP
2. *The Magic Box*	3 reels,	color,	MTP
3. *Winning Seals of Approval*	2 reels,	color,	MTP

An excellent two-reel motion picture, *Fraud Fighters* (USD), is available from the United States Pure Food and Drug Administration. This shows how this agency acts to protect the consumer from willful or accidental injury from spoiled or adulterated food and medicine. A one-reel film treating this topic generally is *Unseen Guardians* (TFC). *The Story of Milk* (MTP), three reels in color, tells how milk is made safe for human consumption. A one-reel motion picture, *Consumer Protection* (COR), in black and white or color, explains how it is possible for the average family to take advantage of the wealth of information available from both government and private consumer services to help them buy wisely and enjoy an improved standard of living.

The use of plastics might easily be introduced by pictorial displays on this topic. Much material is available in household magazines. Exhibits of small articles made of plastics might be interesting as a group activity. Pupils may wish to try their hand at embedding small objects, insects, or other materials in clear plastics available for school use. Biological Supply Houses specialize in embedded specimens for class use. Two motion pictures are available to show the pupils how plastics have taken their place in modern life, *Plastics* (ALF), one-reel black and white, and *Kingdom of Plastics* (GE), one-reel in color.

The topic of advertising and consumer education might be stimulated by bulletin board displays of advertising materials from popular magazines. Individual pupil excursions might be encouraged for study of the needs of consumer education. A one-reel motion picture, *Home Management: Buying Food* (YAF), and a filmstrip, *Consumer Problems in Nutrition* (PSP), forty-four frames in color, are available to enrich this unit.

Judging home electrical appliances for good consumer values might bring in the use of a filmstrip, *Making Your Kitchen Efficient* (GE), and two motion pictures, *Home Electrical Appliances* (EBF), one-reel black and white, and *Your Ticket to Better Buying* (WES), two-and-a-half reels black and white. Judging values in clothing, another topic in consumer education, might be introduced by the use of a filmstrip series, *Consumer Education* (YAF). Six black and white strips make up the series. The titles are descriptive of the contents: (1) *How to Buy a Blouse*, (2) *Select Your Style*, (3) *Your Retail Store*, (4) *Facts about Wool Fabrics*, (5) *Facts about Cotton Fabrics*, and (6) *Facts about Rayon Fabrics*. A two-and-a-half reel motion picture in color, *Dear Miss Markham* (MTP), might be useful in helping pupils understand how cloth is made and tested.

Sources of Motion Pictures and Filmstrips

ALF Almanac Films, 516 Fifth Ave., New York, N.Y.
COR Coronet Films, 65 East South Water St., Chicago, Ill.
EBF Encyclopaedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill.
GE General Electric Co., Advertising and Sales Promotion, 1 River Road, Schenectady, N.Y.
MTP Modern Talking Picture Services, 45 Rockefeller Plaza, New York, N.Y.
PSP Popular Science Publishing Co., A-V Division, 353 Fourth Ave., New York, N.Y.
TFC Teaching Films Custodians, 25 W. 43rd St., New York, N.Y.
USD U.S. Food and Drug Administration, Dept. of Health and Education, Washington 25, D.C.
WES Westinghouse Electric Corp., School Service, 306 Fourth Ave., Pittsburgh, Pa.
YAF Young America Films, 18 E. 41st St., New York, N.Y.

SPECIFIC HEAT DEMONSTRATION

JOSEPH A. MACK
St. Michael High School, Chicago 14, Illinois

The catalogues of scientific instrument supply houses list *Tyndall's Specific Heat Apparatus.* This consists of five or six spheres of different metals but of the same diameter. In one form these spheres are supported on a pegged bar. In another form the spheres are supported on a six-pronged spider. In both cases these spheres are to be raised to the same temperature, that of boiling water, and then are to be allowed to melt through a paraffin sheet. As the spheres are of identical diameters their masses are directly proportional to the specific gravity of each. The results obtained by this demonstration are confusing to the student who expects the melting depth to be proportional to the specific heat of the metals. One catalogue deemed it necessary to call attention that this is not to be expected by the explanation "they will melt through the paraffin in time intervals which are inversely proportional to their specific heats."

A demonstration apparatus not obtainable in this country and presumably of European origin is diagramed in Black and Davis, *Elementary Practical Physics.*[1] We believe this apparatus to be better for demonstration purposes because directly measured results are immediately available. Basically this apparatus consists of cylinders of different metals but of equal weight and equal diameter. As they are of equal weight and equal diameter they exert equal pressures when standing on end. After heating, these rods melt into a paraffin sheet set on end. The depth of melting is in direct proportion to the specific heat of the metals.

In looking for materials to construct such a demonstration piece, we found in the supply house catalogues listed as *Specific Heat Specimens,* "five cylinders of approximately 19 mm. diameter of lead, copper, tin, zinc, aluminum, of such length that they will all have the same weight." This weight was found to be approximately seventy grams. The rods are $\frac{3}{4}$ inches in diameter. Since there is a gap in the sequence of specific heats, a cylinder of iron is indicated. Such iron rod is available everywhere. Its length would be about 3.0 cm. at the start. As zinc and copper have approximately the identical specific heats, the iron cylinder may be substituted for either one.

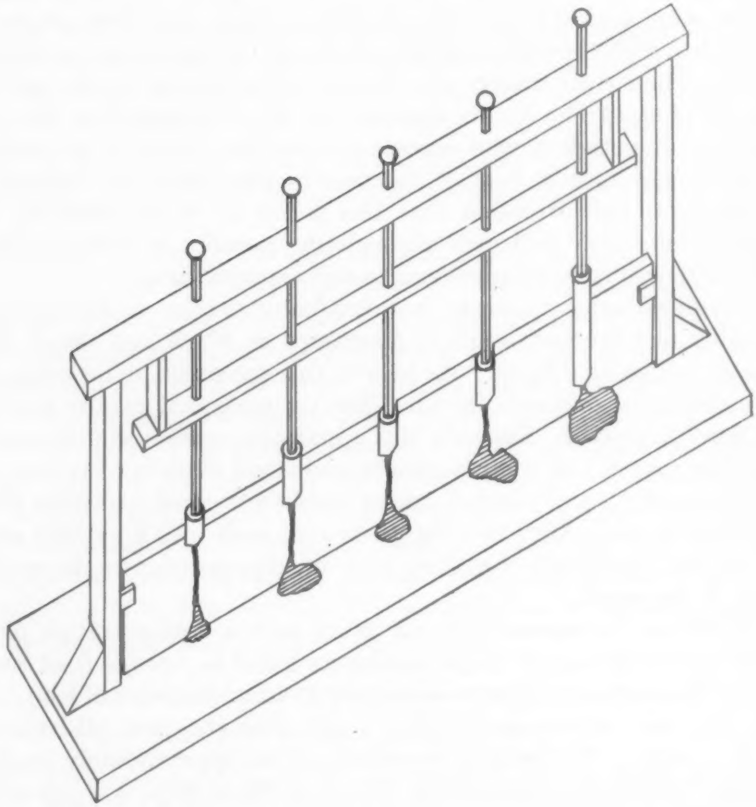
To give better attack on the paraffin, the cylinders should be bevelled at their lower ends to make a knife-edge either of 90° or 120°. As this removes different weights for each metal, adjustment in weight must be made at their upper ends to bring the rods back to

[1] Macmillan, 1942. P. 270, Figure 13-1.

equal weight. This weight is determined by the shortest, the lead specimen, which in our case was 58.0 g.

To prevent the specific heat specimens from rotating during the melting, they are drilled and tapped to square plastic connecting rods. Plastic was chosen over metal to prevent the introduction of errors due to conduction of heat. These connecting rods were terminated at their upper ends in insulated binding post knobs.

Reduced to a minimum the demonstration will consist of (1) the specific heat specimens bevelled and attached to plastic rods, (2) a



paraffin sheet, (3) a beaker with water to heat the rods. The rods when removed one by one from the water bath are guided by hand and are allowed to melt into the paraffin sheet. This simplest form works as well as the more elaborate one, but requires more time for completion.

If it is decided to have the more elaborate form, one in which the rods are mounted in a guiding frame, one must decide on the number of metals to be used. This number would be five. The next considera-

tion must be their spacing. A one and one-half inch spacing between axes seems adequate. Also, consideration must be given the ends which may be one and one-half inches. To give guidance to the specific heat specimens while they melt into the paraffin, the cylinders with their plastic connecting rods are mounted in a frame. The length of the frame is determined by the number of rods to about nine inches. Vertical guide posts at the extremities of the paraffin are needed to support and direct the frame. The width of the base will be dictated by stability.

A mold to recast the paraffin is also necessary, something on the order of $9 \times 2 \times \frac{1}{2}$ inches. The thickness of the paraffin sheet somewhat determines the depth of melting.

Measurement of the depth of melting can be made with any ruler. The ratios of the depth of melting closely approximate the ratios of the specific heats. Because the American boy is the champion of the underdog the observation may be heard that the lead specimen, be cause it is the shortest, "never had a chance." This may be the opportune moment to unscrew the metals and balance them against each other, demonstrating their equal weight.

Metals	Sp. Gr.*	Lengths*	Sp. Ht.†	Depth of Melt*
Aluminum	2.80	7.70 cm.	0.219	28.0 mm.
Iron	7.90	3.05	0.119	16.0
Zinc	7.17	3.20	0.094	15.0
Copper	8.91	2.67	0.093	13.5
Tin	7.32	3.25	0.055	9.0
Lead	11.3	2.22	0.031	4.5

* Experimental Results.
† From Tables.

HITLER ANTIVIVISECTION LAW STILL IN EFFECT

The only nation in the world which has a national antivivisection law is Germany, the National Society for Medical Research here reports.

The law was adopted early in the Hitler regime and is still in effect.

As a result of this law, the Society finds, all use of animals was banned in medical school teaching and in training of surgeons. In addition, the law placed German scientific research under stringent political control.

Since the law's enactment in 1933 over Hitler's signature, Germany has dropped from a leading position almost to the bottom of the world list in biological research, the Society reports.

Discovery of the unique statute was made through an international survey of animal experimentation laws.

American communities last year built approximately 50,000 new classrooms. The year before they built about 47,000. These were new records. This year we may expect another construction record of about 50,000 additional classrooms.

HOW TO MAKE ARITHMETIC MEANINGFUL IN THE JUNIOR HIGH SCHOOL

HARRY L. STEIN
The University of Manitoba, Winnipeg, Manitoba, Canada

INTRODUCTION

Teachers of mathematics in junior high schools have an excellent opportunity to perform a service for students and, at the same time, to help eradicate a situation about which, justifiably or not, high school teachers complain so bitterly. The complaint is often heard from teachers of high school mathematics that students come to them from the junior high school lacking the *skills* and *understanding* of arithmetic computation. These high school teachers assert that students of upper secondary school mathematics are inhibited in their thinking about mathematical processes because they have to give too much attention to basic tools which should have been mastered much earlier. It is the purpose of this article to show that the junior high school teacher, by using a meaningful approach, can help students to improve their computational skills and to reorient their thinking about arithmetic processes by (a) clarifying anew the nature of the number system, and (b) teaching the rationale of the arithmetic processes as a basis for review and practice.

To what extent junior high school pupils are dependent upon rote memory of the algorisms for the fundamental operations is not known. It is known, however, that at each level of learning there must be a reteaching of the processes to a considerable number of pupils who have forgotten the algorisms and have not the fundamental knowledge to reconstruct them. Much of the reteaching, as it was with the original teaching and learning, utilizes memoriter methods of reacquiring the algorisms. Teachers just *show them how to do it* again, and hope that *this* time, it will stick.

WHY MAKE ARITHMETIC MEANINGFUL?

A meaningful approach in the teaching of arithmetic at the junior high school level to children who have not had the benefit of instruction of this type is most desirable for a number of reasons. In the first place, it is altogether likely that increased comprehension of the number system and of the processes will lead to increased facility and accuracy. In such operations as long division involving decimals, the manipulation of the fractions, and the solution of problems involving percentages, an understanding of the number system should lead to greater ease in making decisions as to where to place the decimal point, in deciding whether the result should be an increase or a

decrease in original values, and in checking results for reasonableness. Many students are unable to judge the accuracy of an answer to a problem because of a lack of comprehension of number relationships.

In the second place, understanding may be a motivating factor in learning. It is distinctly possible that many children who are bored by, and who become disinterested in, routine operations which they do not fully comprehend, may be spurred on to greater efforts when what they are doing is meaningful to them. Routine, repetitive examples have a peculiarly deadening effect upon many children, causing them to deteriorate in speed and accuracy with practice, rather than to improve. Placing the routine operations in meaningful social settings may serve to alleviate some of the boredom resulting from blind repetition of the operations in abstract. Much may be gained, too, from the richness of the social settings.

In the third place, understanding may give the student a feeling of power to attack new problems without fear of the consequences of not understanding his tools or knowing how they operate under various conditions. Many students tremble when they face the task of solving fractional equations in algebra because they do not understand the commutative, associative and distributive laws of elementary arithmetic, and the laws upon which operations with fractions depend.

Fourthly, understanding should enable the student to diagnose any errors in his operations. If the student understands the fundamental operations, he should be able to check his work more carefully and to find out more easily where and why he has made errors in his computation. If his fractions turn out larger or smaller than he expects, understanding will help him find out why. If his decimal point appears to be in the wrong place, he has a means of investigating the situation.

How to Make Arithmetic Meaningful

Having considered some of the reasons for making arithmetic meaningful we should now examine some of the methods and techniques for achieving this objective. We should remember, of course, that we are considering pupils at the junior high school level, and that they have a considerable background of useful number experience.

First, it is possible in the junior high school to teach the rationale of the fundamental operations and the algorisms connected with these operations. Then, the junior high school teacher has an opportunity to extend comprehension of number through the mathematical phase of arithmetic. Particularly, the processes of subtraction, multiplication, and division of whole numbers can be rationalized. More

extensive checking procedures can be developed and explained. The processes with fractions and decimals can be explained in the light of the operational principles and generalization. What can and cannot be done with fractions and decimals can be examined on a much higher mathematical level than can be reached in the elementary school. Finally, the drabness of repetitive review and drill can be removed by treating the situation as a basis for new discovery on the part of the pupils. Experimental and cooperative techniques can be utilized in developing the *new* insights into the fundamental operations with all kinds of numbers.

Secondly, arithmetic can be made meaningful in the junior high school by utilizing concrete situations and by moving gradually from the concrete to the abstract and symbolic. It should not be assumed that because children have reached the age of twelve and thirteen and have been using arithmetic in the abstract for a couple of years in the upper elementary grades, they are beyond the level where concrete materials are useful in the teaching process. It is just as reasonable for junior high school pupils to use markers, pegs, or an abacus to gain insight into the meaning of the operations as it is for them to study plants and animals objectively rather than from pictures in a book. Junior high school teachers should not consider it beneath their dignity to utilize concrete materials to develop abstract processes.

Thirdly, arithmetic can be made meaningful at the junior high school level, as at any other level by introducing each new concept through the medium of a real problem within the range of comprehension and experience of the pupils. In the junior high school enough real situations involving number and quantitative concepts in general arise in all areas of the curriculum to take care of the needs of arithmetic so that there is little need to utilize artificial and unreal problem situations. The motivating effect of the reality in the situation should overcome any inherent difficulties in the problem.

A fourth requirement in making arithmetic meaningful is the recognition of the principle of individual differences, applied specifically in allowing pupils to proceed at their own rate of comprehension and growth. It should be remembered that insights and understandings will occur when conditions are right and when the pupil is ready. Forcing learning of rote methods merely to produce results without understanding may well cause loss of interest, and prevent individuals from striving for the insights necessary to produce successful achievement.

Finally, understanding may be furthered by stimulating interest in arithmetic and mathematics through historical anecdotes, simple puzzles and other recreations. Challenge is basic to interest, and suc-

cessfully meeting a challenge is a spur to further interest and further effort.

What Arithmetic Can We Make Meaningful?

The opening lessons of grade VII arithmetic are usually concerned with a review of the fundamental processes. Here, then, is a splendid opportunity to stimulate and motivate junior high school pupils in the study of arithmetic. They are fairly mature; they have had considerable experience and practice with number; they will appreciate an introduction to some of the finer aspects of the subject and, at the same time, they will acquire insights that will be of inestimable value to them in the comprehension of the new concepts they will learn in the junior high school.

There are not many new concepts to learn in grade VII as far as the mathematical phase is concerned. In the main, they are: 1. Division by a three figure number; 2. Division by a decimal fraction; 3. Finding a per cent of a number; 4. Finding what per cent one number is of another; 5. Finding areas of certain figures; 6. Beginning the informal geometry of shape.

In grade VIII the new processes to be taught are: 1. Finding a number when a per cent of it is given; 2. Finding the volume of certain solids; 3. Extension of the informal geometry of size, shape and position; 4. Indirect measurement by scale drawing; 5. Ratio; 6. Square root; 7. Simple equations and signed numbers.

In grade IX there are no new concepts to be taught as far as the mathematical phase of arithmetic is concerned.

What better opportunity is there, then, to open the junior high school period of arithmetic with a thorough review (or, in some cases, a new presentation) of our number system and its notation.

Here, in outline form, are some of the ideas that may be presented and discussed.

1. The origin of some of our number symbols, e.g.

−	=	≡	+	5
1	2	3	4	5

2. Our number system and its decimal notation. Our system is the Hindu-Arabic system of notation. It requires only ten symbols, nine digits and a zero. By means of these ten characters it can express the largest and the smallest integers and fractions. It does so by using the additive principle of place value, utilizing zero as a place holding device (2).

3. Many number concepts which may have been ill-understood or not understood at all in the earlier grades can, at this level, be rela-

tively easily cleared up. Among these concepts are cardinal and ordinal numerals, abstract and concrete numbers, the meanings of fractions and the rules and principles for operating with them, and, for some of the more advanced pupils, such concepts as complex numbers and square root may be discussed.

4. The rationale of the fundamental operations may be dealt with very thoroughly in these grades. In addition, the laws of commutation and association can be discussed, along with the rules of "likeness" and "compensation." In subtraction, the notion that it is the reverse of addition can be taught with meaning, and the terminology minuend, subtrahend, and difference can be explained fully. Other methods of subtraction than the take-away borrowing method can be explained as a matter of interest. Multiplications of whole numbers can be taught as repeated addition, while division of whole numbers can be thought of as repeated subtraction. It is much easier to teach the rationale of the division algorism at this grade level than at any earlier grade.

5. The rationale of the fundamental operations with fractions of all kinds can be dealt with in such a way that meaning and comprehension result. Certainly high school teachers will be grateful for any "fixing" of fraction skills needed in upper level mathematical manipulation.

6. The rationale of short methods of computation also finds a place at the junior high school level. Short methods of multiplying by 11, of dividing by 25, of multiplying and dividing by powers of ten, etc. all make fascinating and profitable lessons.

The teacher of junior high school mathematics can, then, render a genuine service to his pupils and to the teachers of secondary mathematics by doing his utmost to develop the mathematical phase of arithmetic meaningfully.

The following bibliography will be found very helpful to teachers of arithmetic at all grade levels:

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Although 45,700 graduates trained as elementary teachers came out of the colleges this year, there is still a net shortage this fall of 72,000 teachers in our grade schools.

GUIDANCE—A PART OF SCIENCE TEACHING

NELSON L. LOWRY
Arlington Heights High School, Arlington Heights, Illinois

Few things, whether ideas or skills, acquired in school are used in precisely the way in which they are learned. As teachers in the secondary school, we must accept the fact that differences, often large, do occur between the learning situation and situation of use.

Teachers of science have not always helped the student to apply facts learned to practical personal ends. There should be more application of meanings and significances and potential application to life experiences.

Many science teachers have placed little emphasis on helping the individual to be understood by himself as well as by others. The student is aware that complexity of the world in which he is destined to live offers many problems; and still providing the individual with consistent, unified assistance in meeting problems has at times been neglected.

To the adolescent, in which intellectual growth is rapid, there exists problems related to life situations. The understanding the child has of these will effect his activities as he becomes an adult and a member of modern society. Well planned guidance services are needed if the individual is to achieve the highest possible degree of personal and social competency.

The science teacher is not expected to be a thoroughly trained guidance worker. But it can be expected that he will develop an appreciation of functions and practices of guidance, and will be able to recognize and observe significant pupil attitudes and behavior.

The success of the guidance program may be determined by changes in the behavior pattern of the individual. Behavior response to a given situation may be thought of as a problem, and the success that an individual has at solving problems may be observed in his behavior.

Science teaching becomes meaningful to the learner as we set problems related to experiences that have a meaning to the learner. We have the task of developing skills and attitudes so that the learner will proceed to solve problems. In order for problem solving and critical thinking to occur, the student needs guidance in developing an attitude of being disposed to consider in a thoughtful way the problems and subjects that come within the range of one's experience. There is need for knowledge and method of logic inquiry and reasoning along with skill in applying these methods. It is these things the student should have the opportunity to acquire in the science class.

Class activities in science offer an excellent medium for assisting

pupils to discover their assets and limitations as they experience problem solving. In daily association with pupils, in varied learning situations, the science teacher can observe work habits and special abilities, and attitudes that are essential to an understanding of the individual and helping the individual to understand himself.

Training of the science teacher in seeking solutions to problems, careful observation, valid reasoning, experience in interpreting data, and understanding the impact of science on world events should prove valuable while guiding youth in problem solving situations.

Among those objectives usually described for science teaching is development of ability to think critically. This can come about only as one has something with which to think—meaning—understandings. The ability to solve problems comes from the habitual response in the right way and blocks out other possible reactions.

It is through a variety of meaningful experiences that students develop a sense of understanding. Individuals differ; the skillful teacher will recognize these differences and give intelligent guidance in directions as may be necessary to develop a sense of understanding.

Science teachers at times use descriptions of procedures in problem solving rather than applying techniques. It becomes our responsibility in science to assist the student in seeing how techniques apply generally and not only to the problem in the science class that is being solved. The procedures used in dealing with scientific materials need to be translated into terms general or broad enough to be applicable to any type of problem that the student may face in life. Problem solving becomes meaningful as it relates to life situations.

As experiences become meaningful, under the guidance of the science teacher, the pupil becomes acquainted with himself. He no longer is studying science because it is science; but rather he can see himself in terms of abilities, knowledge, limitations, and interest as he makes intelligent choices of vocational and educational opportunities in science and the various fields related to science.

WANTED: COPIES OF SCHOOL SCIENCE AND MATHEMATICS

Mathematics Editor, C. B. Read, is very anxious to complete his back files of School Science and Mathematics. If anyone has the following issues and is willing to sell them please notify Professor Read, University of Wichita, Wichita 14, Kansas.

Volumes II, III, and IV (1902–1904).
Volume VI, issues following No. IV (1906).
Volume XI (1911).

Schools and colleges during the 1953–54 academic year will enroll the largest number of pupils and students in history—36,949,700. This is about 2 million more than last year.

WHAT ARE COSMIC RAYS?

SISTER HELENE VEN HORST
Marycrest College, Davenport, Iowa

At this very instant the earth and its atmosphere are being bombarded by vast numbers of particles whose energy is thousands of times greater than that of atomic radiations! This mysterious influx has been a problem of extended investigation during the past half century. Particles whose energy is millions of times larger than that produced in the present day cosmotron are naturally of very great interest to physicists. Current investigation with high energy equipment has put an upper limit of 10 billion electron volts of energy on such particles. Yet estimates of the energy of primary particles making their way through the upper layers of the atmosphere are of the order of 10^{15} electron volts or a hundred thousand times greater than that which is expected in a man-made accelerator!

What are these particles? Where do they come from? What is their importance from a scientific point of view? These questions are of interest to the layman as well as the scientist. But even the scientist is not in a position to answer them completely.

Two outstanding discoveries made with cosmic rays during the past two decades are sufficient proof that this field of scientific investigation is significant. The positron was first detected in a photographic plate of cosmic ray events. Not many years later another great contribution was made in the discovery of the meson. Both of these particles have helped to understand the fundamental nature of matter and to confirm postulates made heretofore concerning its structure. Other particles whose role is not fully understood have been detected in cosmic ray studies. All of this gives evidence of the tremendous possibilities which exist in nature for the study of the intricate and minute structure of matter. Man has tried to duplicate conditions which exist in nature. Huge pieces of apparatus have been and are being constructed for the purpose of accelerating particles equal to the energies found in the universe—the kevatron, the linear accelerator, the betatron, the cosmotron and others. Yet the energy of even the most powerful of man's apparatus is only of the order of one ten-thousandth of that which accelerates the high energy particles bombarding the earth and its atmosphere.

But where do these high energy particles come from? In the early history of cosmic rays many hypotheses were made regarding their origin. However, with the increase in knowledge concerning their complexity, less of such speculation is proffered. Perhaps when more is known about the properties of these particles, more sound hypotheses can be made concerning their origin.

A glance at the literature is sufficient conviction that cosmic rays are no longer the complete mystery they were several decades ago. It is hoped that this short article will summarize in a qualitative way some of the facts that are known and more specifically that which is of general interest concerning cosmic rays.

These high energy particles may suitably be classified into two groups: the primary particles, or those which initially enter the atmosphere, and the secondary particles, or those which result from a bombardment of the primary particles with matter. Contrary to relatively recent belief, the larger percentage of primary particles which enter the atmosphere are protons. The energy spectrum indicates that approximately 91% of the particles are protons; 8% are alpha particles; 0.4% are nuclei of carbon, nitrogen, and oxygen; while 0.2% are nuclei of atomic number equal to or greater than 10. The secondary particles at sea level consist of electrons, photons, and mu mesons. It would be expected that such a condition would lead to the existence of a maximum intensity of radiations at some point in the atmosphere. This condition exists about 85 thousand feet above sea level. However, this altitude for the maximum intensity varies somewhat, depending on whether only the vertical component of radiations is considered or if the total radiations coming from all directions is determined. Above this level the intensity recedes rapidly due to the existence of mainly primary particles at very high altitudes.

A possible pattern for the increase in intensity of cosmic rays is as follows: Bare nuclei, chiefly protons, of extremely high energies penetrate the upper layers of the atmosphere. Because of the scarcity of oxygen and nitrogen molecules, or in fact of any kind of matter, there are very few collisions in these regions. However, as the density of the atmosphere increases, the probability of collisions is much greater and as a result the intensity of cosmic radiations is increased by a variety of processes. For example, a proton, alpha particle, or other high energy primary particle collides with a molecule in the atmosphere and produces neutrons, neutral and charged pi mesons, electrons and additional protons. The neutron might decay, without interacting, into a proton, electron and neutrino. However, it is estimated that 96 per cent of the neutrons react with the nitrogen of the atmosphere to produce radioactive carbon.* The neutral meson decays into two gamma rays each of which in turn decays into a positron and an electron. The charged pi mesons decay into correspondingly charged mu mesons and neutrinos. Pi mesons are formed only if the energy of the bombarding particle is sufficient to exceed the binding energy of the nucleons. The pi mesons which are thus produced may

* Carbon 14 behaves chemically the same as carbon 12. Because of its relatively long half life it is currently being used to determine geological ages.

range considerably in energy. Low energy charged pi mesons decay into the correspondingly charged mu mesons. High energy negative pi mesons, on striking the nucleus, are absorbed by it. The entire process may be thought of as a chain of reactions in which initial particles of very high energy collide with molecules in the atmosphere to

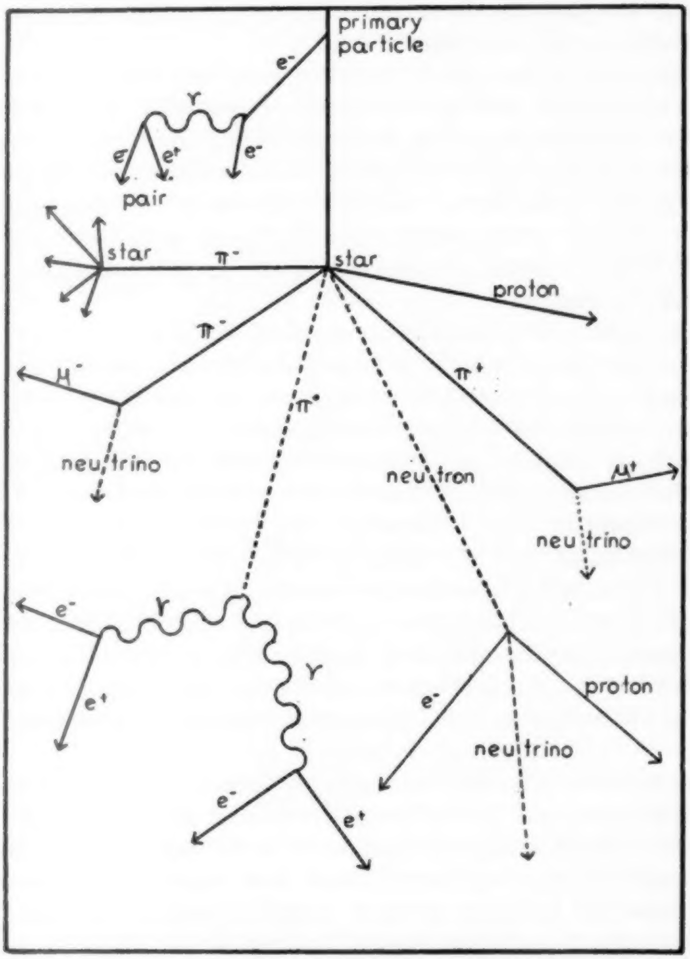

FIG. 1. A schematic diagram of possible events in cosmic radiations. Dashed lines are not observed in actual studies.

produce very large numbers of particles of decreasing energies. A schematic diagram of possible events observed in cosmic rays is shown in Figure 1. The formation of multiple tracks, or stars, results from the collision of a particle with a nucleus. The products formed include alpha particles, pi mesons, protons, and neutrons. The latter

are not observed, however. If a primary particle collides with a nucleus, the resulting star may consist of up to a hundred branches. Smaller stars are produced by negative mesons entering a nucleus.

It would appear that the quantity of radiations increases continuously as the particles traverse the atmosphere. However, it can be seen that as a result of collisions, ionization, and decay processes, the energy of the particles decreases. Ultimately no further interactions are capable and the reactions die out.

The question might rightly be asked as to *why these charged particles do not interact with stray electrons or protons to produce neutral particles.* This is explained on the basis of reaction time. In order for particles to react a certain length of time is required for the process. The very high velocities of these particles make such a process impossible. Hence, reactions take place only on actual collision of a particle with the necessary reactant, or the particle undergoes radioactive disintegration.

In addition to the classification of primary and secondary particles in cosmic rays there is a distinction made between the soft and hard components of the secondary radiations. The soft component is, as the term implies, not very penetrating and consequently very readily absorbed. At altitudes of 35 hundred meters the soft component is three times more abundant than the penetrating component. The degree of absorption of this component is proportional to the square of the atomic number of the absorber. The hard or penetrating component is absorbed proportional to the first power of the atomic number of the absorber. As a logical consequence we find that the intensity of this component increases only slightly with an increase in altitude. It is this latter component of radiations that has been detected at a depth of 610 meters in a coal mine, or an equivalent of 1600 meters of water.

Is the intensity of cosmic radiations uniform over the earth's surface? The earth's magnetic field is decidedly effective in determining cosmic ray paths. The abundance of radiations in the region of the magnetic poles would be expected. Studies have been made which show a definite increase of intensity of these particles with an increase in degrees latitude. A minimum intensity occurs at the magnetic equator. The intensity here is approximately 10 per cent less than that at 45 degrees north and south latitude. Beyond this point, however, the intensity increases only slightly. The magnetic effect is explained in the following manner. If a particle moves in a direction perpendicular to a uniform magnetic field, its path becomes circular. The radius of the circular path will depend, of course, on the energy of the particle. If the magnetic field is not uniform, or if the particle moves at any angle other than zero or ninety degrees with the magnetic field, it

results in a spiral or helical path about the lines of the field. The earth's magnetic field also acts as a shield for particles of low energy. Only particles of over a billion electron volts can reach the atmosphere. This value depends upon the type of particle and the geomagnetic latitude. In the case of protons in the vertical direction the minimum energy is of the order of 15 billion electron volts.

What is the approximate energy contributed to the earth and its atmosphere by cosmic rays? It has been estimated that the number of primary particles that strike the surface of the earth's atmosphere per second is of the order of 8×10^{17}. On this basis the total power carried by cosmic rays is approximately one million kilowatts per second. The number of particles which strike the earth at sea level is 1.5 per square centimeter per minute. Roughly, a total of 1.5×10^{17} particles fall on the surface of the earth per second!

How does the energy of cosmic rays compare with that of radioactive particles? The majority of particles in cosmic rays have energy of the order of 2 billion electron volts. This energy is approximately a thousand times that of radioactive nuclei which are only a few million electron volts. By way of comparison, the energy of ordinary chemical reactions is of the order of several electron volts per molecule.

How is the energy of these particles detected? Charged particles alone are detected by the direct ionization which they produce. Since neutral particles and gamma rays decay into charged particles, their paths are assumed to exist in those areas where certain charged particles have their origin. Detection of neutrons is made possible by a gas multiplication process. The boron 11 isotope captures the neutron and produces helium and lithium, both of which are easily ionized and produce a high pulse in the counter. Probably the most common of the instruments used to study cosmic rays is the cloud chamber. The principle of this instrument is based on the application of a strong magnetic field to the chamber. The magnetic field causes the paths of the charged particles to become curved. From the magnetic curvature, the specific ionization and scattering, and the range, the identity of the particle is determined. In addition to the cloud chamber, observations and studies of cosmic rays are made by means of photographic emulsions, coincidence arrangements of Geiger-Mueller counters and pulse-ionization chambers. These instruments are carried to altitudes as high as 100 thousand feet by helium filled balloons. Sometimes they are flown in planes, or transported to the peaks of high mountains. Observations are also made in caves, mines, and under water.

This brief account of one of today's most promising fields of scientific research is not intended to be comprehensive. It is written in the hope that others may become better acquainted with the physical

world in which we live. A list of current books and articles in which additional information can be found is appended.

Acknowledgment is made to Professors E. P. Ney and J. R. Winckler for their stimulating discussions of cosmic rays at the Institute of College Teachers of Physics sponsored by the National Science Foundation at the University of Minnesota during the summer of 1953.

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SCIENCE TEACHERS IN SHORT SUPPLY

A shortage of qualified science teachers for junior and senior high schools may prove to be the most serious bottleneck in the production of technically trained personnel for science and engineering. The decrease in the number of new teachers graduated by the colleges each year since 1950 is greater in science than in any other field. The 1953 yield was only about 4600 new teachers for the entire nation. This is 49 per cent under the class of 1950 and many of these are not actively seeking employment as teachers.

The above information is given by Dr. Ray C. Maul. Dr. Maul is Associate Director of the Research Division of the National Education Association.

According to Dr. Maul, "The onrush of American industrialization, [and] the spread of American influence to every part of the globe—all this can be traced directly to the prevalence of resourceful, thoroughly trained men and women. Scholars in the sciences have been, and are, the foundational stone in this structure. Our plentiful supply of inquisitive researchers, those who build the American 'know-how,' can be accounted for in easy, understandable language. We have identified a larger percentage of capable youth than any other nation. It has been a case of making greater utilization of our potential."

Continuing, Dr. Maul points out that "All too little credit has reverted to the teacher. Often it is touch-and-go with a student. In thousands of cases it is the teacher who fans a spark into a flame of curiosity. The number and quality of the scientists of tomorrow are being determined in the classrooms all across the nation today. If the American school is to sift the high school population for the next decade so that every student with scientific aptitude is to be identified and encouraged—if we are to fortify our American society two, three, and four decades hence with leaders of resourcefulness, creative imagination, and a sound understanding of science, then we must reckon with the dwindling supply of qualified science teacher candidates now trickling from the colleges."

By 1960 it is estimated that there will be 10 million more pupils and students in our nation's schools and colleges, both public and private, than there were last spring.

ON THE DEFINABILITY OF ZERO TO THE POWER ZERO

ROBERT S. FOUCH
Arizona State College, Tempe, Arizona

In the face of the many excellent articles on the subject of zero and negative exponents that have appeared in this journal[1] and elsewhere it may seem foolhardy to offer anything more. However, there appears to be a curiously neglected detail concerning the zero exponent and it is my purpose here to try to show the existence of a minor, but surprising, defect in the usual treatment of 0^0.

I have recently examined twenty-six intermediate and college algebra textbooks, all published within the last ten years, and it may be of interest first to mention the results of this small survey. It is encouraging to find that only two of these books pretend to *prove* that $x^0=1$; all the others make it clear that this is a definition, whose purpose is to extend the previously derived properties of positive integral exponents. On the other hand, it is somewhat dis ouraging to find that only eleven of these books are careful enough in their statements to exclude the possibility of zero divisors in such laws as $(x/y)^m=x^m/y^m$; the importance of this for our purposes here will become clear later. In their definitions of x^0, twenty-five of these texts make the parenthetical remark that $x\neq 0$; whether the twenty-sixth omitted this exception intentionally or carelessly is not clear. It is again a little discouraging to notice that only two of these authors state any reasons for their exclusion of zero. In paraphrase, the arguments of these two writers are of this sort: "If we let $m=n$ in the law that $x^m/x^n=x^{m-n}$, we obtain $x^m/x^m=x^0$. But $x^m/x^m=1$, unless $x=0$. The value of 0 for x must be excluded since it would produce the indeterminate $0/0$ on the left side of this equation." It is my feeling that such remarks smack slightly of the notion that we are actually proving something in this way and it is my contention that this does not show any need for excluding zero from the definition. I shall now try to show that the definition $0^0=1$ also preserves the previously derived properties of exponents.

In Table 1 are listed the usual five properties of positive integral exponents, with the proper exclusions of division by zero. It is understood that we now allow exponents to be zero and that we allow the bases to be zero, wherever not expressly forbidden. In each case, the problem in the right column is solved in two ways: on the top line, by means of the law in the left column; on the bottom, by performing the operations in the order indicated, with the assumption that $0^0=1$.

[1] For example: Niessen, Abraham M., "The Extension of the Exponent Concept," SCHOOL SCIENCE AND MATHEMATICS, November, 1948, XLVIII: 605–10.

I have tried to exhaust the cases in which 0^0 can properly appear in each of these properties.

TABLE 1

I. $x^m \cdot x^n = x^{m+n}$	a. $0^0 \cdot 0^n$	$=0^{0+n}=0^n=0$
		$=1\cdot 0^n=1\cdot 0=0$
	b. $0^0 \cdot 0^0$	$=0^{0+0}=0^0=1$
		$=1\cdot 1=1$
II. $x^m \cdot y^m=(xy)^m$	a. $0^0 \cdot y^0$	$=(0\cdot y)^0=0^0=1$
		$=1\cdot y^0=1\cdot 1=1$
	b. $0^0 \cdot 0^0$	$=(0\cdot 0)^0=0^0=1$
		$=1\cdot 1=1$
IIIa. If $x\neq 0$ and $m>n$, then $x^m/x^n=x^{m-n}$	$0^m/0^0$	(Law not applicable, since we must have $x\neq 0$)
IIIb. If $x\neq 0$ and $m=n$, then $x^m/x^n=1$	$0^0/0^0$	(Law not applicable, since we must have $x\neq 0$)
IIIc. If $x\neq 0$ and $m<n$, then $x^m/x^n=1/x^{n-m}$	$0^0/0^n$	(Law not applicable, since we must have $x\neq 0$)
IV. If $y\neq 0$, then $x^m/y^m=(x/y)^m$	$0^0/y^0$	$=(0/y)^0=0^0=1$
		$=1/y^0=1/1=1$
V. $(x^m)^n=x^{mn}$	a. $(0^0)^n$	$=0^{0\cdot n}=0^0=1$
		$=1^n=1$
	b. $(0^m)^0$	$=0^{m\cdot 0}=0^0=1$
		$=0^0=1$
	c. $(0^0)^0$	$=0^{0\cdot 0}=0^0=1$
		$=1^0=1$
In all cases, $m>0$ and $n>0$		

It will be seen that in no case is any contradiction produced. On the basis of these results it is therefore claimed that the definition $0^0=1$ is allowable insofar as we are concerned with extension of the exponent laws.

The careful reader may wonder whether we might not equally well say that $0^0=0$, or perhaps some other number. If the reader will re-

peat the work shown in the table, using $0^0=0$, he will find that this also avoids any contradiction; however, if one uses some value other than zero or one, he will find that problem *b* of property *I* and problems *a* and *c* of property *V* do produce contradictions. Therefore the only acceptable values are zero and one. There remain, then, three possibilities: not to define 0^0 at all, to define it as 1, or to define it as 0. In the interests of simplicity and generality (which are commonly used criteria for the judgment of mathematical systems), it would seem preferable to define it as 1.

There is other evidence for the desirability of this definition in the work of numerous mathematical logicians, beginning with Frege, Cantor, and Russell. It would be inappropriate here even to sketch the reasoning involved in their treatments of exponentiation since they necessitate considerable use of logical symbolism and of such concepts as the null set and null functions. It should be sufficient here to state that, following the set-theoretic approach, it is possible to make a general definition of x^m, where x and m are any cardinal numbers,[2] which then leads to the *theorem* that $x^0=1$, without any exception of zero. Such a definition has the great advantage that it gives us easy answers about infinite (properly, transfinite) bases and exponents; it has the disadvantage that it does not apply to negative or fractional bases.[3]

Another view of the problem may be obtained from the work of Quine,[4] who makes a general definition of x^m as the number obtained from 1 by m multiplications by x, where x and m are any non-negative integers. Again, it becomes possible to prove a theorem that $x^0=1$, without any exception of zero. Quine's approach has, I believe, considerable heuristic value and is easily adapted to even the high school classroom. This can be done very simply by changing the usual definition of the positive integral powers to:

$$x^4 = 1\cdot x\cdot x\cdot x\cdot x$$
$$x^3 = 1\cdot x\cdot x\cdot x$$
$$x^2 = 1\cdot x\cdot x$$
$$x^1 = 1\cdot x$$
$$x^0 = 1$$

In this way, the definition of x^0 is obtained very naturally and without the usual difficulties. It has the further advantage of making possible the following heuristic argument for the extension to negative

[2] By a cardinal number is meant zero, a positive integer, or one of Cantor's alephs (the transfinite cardinals).

[3] The classic work on this subject is Cantor, Georg, *Contributions to the Founding of the Theory of Transfinite Numbers*. LaSalle, Ill., Open Court Publ. Co., 1941. See especially pages 94–97.

[4] Quine, W. V., *Mathematical Logic*, Cambridge: Harvard University Press, 1947, p. 259.

exponents. "Since negative numbers are always, in some sense, the opposite of positive numbers and since the opposite of multiplication is division, the expression x^{-m} should mean that we divide 1 by x, n times. Thus,

$$x^{-1}=1/x$$

$$x^{-2}=1/x\cdot x$$

$$x^{-3}=1/x\cdot x\cdot x, \text{ etc.''}$$

It is probably in order to discuss the significance, if any, of what may seem to be a mathematical molehill. I must confess that I doubt that the matter has any significance whatsoever for mathematics per se; at any rate, I cannot remember ever having been in a situation where I needed a value for 0^0, although such situations may perhaps exist. The significance, I believe, lies rather in the direction of our teaching practices. That dozens of text writers, hundreds of teachers, and many thousands of students should have passed without trouble over this point seems to me another indication that we are failing both to teach and to practice critical thinking in our mathematics classrooms. That such a point should be almost universally ignored seems to indicate that we and our students have learned merely to accept what the books say and to do what we are directed to do. Perhaps it is because of slipshod practices such as this that mathematics is losing the position of value which it once had. As for positive implications, I would suggest that students be asked why their textbooks make this exception to the definition of the zero exponent and that they be encouraged to reason the matter through very carefully. I cannot believe that there is anything more difficult in the first part of this discussion than in much of our work in algebra. If a student reaches any conclusion at all, I believe that he will have learned a great deal about mathematical definitions and about the nature of mathematical thought.

ANTI-FLY WASPS HELP FARMERS SAVE WHEAT

Our bread would be scarcer and costlier if it were not for a wasp-like parasite that attacks the hessian fly.

This fly is the most serious insect pest of wheat in the United States. But the wasp-like parasite destroys more than half of each year's crop of the flies, U. S. Department of Agriculture scientists report.

They caution, however, that farmers dare not let up on recommended control practices such as the planting of fly-resistant wheat varieties and planting in the fall after the fly-free date. This late planting protects the wheat by interfering with the natural life cycle of the fly.

One out of every five pupils will go to school this fall term in a school house which does not meet minimum fire safety conditions.

HOW IMPORTANT IS ANIMAL EXPERIMENTATION TO MY HEALTH?

A TEACHING UNIT FOR GRADES 4–8

MARY SANDERS
Parker High School, Chicago, Ill.

I. Statement of Objectives
- A. To gain an understanding that animal experiments help make our lives longer and happier.
- B. To become familiar with some of the recent developments in medicine and surgery made possible through animal experimentation.
- C. To learn how the animals are cared for in the research laboratory.
- D. To gain knowledge of the contributions made to research by "Health Heroes."
- E. To inform students of the work of the various organizations to promote medical research through the use of animals.
- F. To appreciate the efforts made by scientific workers to preserve human lives and prevent sickness.

II. Concepts
- A. Why are animals important to research?
  1. Kinds used.
  2. Expense involved.
  3. Availability.
  4. Maturity, breeding and size—all factors to be considered.
  5. Testing safety and effectiveness of medicines, drugs, and insecticides.
- B. How has animal experimentation contributed to progress in medicine?
  1. Penicillin—developed in various forms, tested and standardized through animal experimentation.
  2. Sulfa drugs—tested on animals to determine their uses and limitations.
  3. Insulin—developed by Dr. Frederick Banting and Charles Best in Canada in 1922 through experiments on several dozen dogs.
  4. Vitamin A and vitamin B—developed with the aid of rats and other animals.
  5. Streptomycin—discovered by Dr. Selman Waksman in experiments on mice, guinea pigs and other animals.
  6. Causes of shock disclosed and means devised for its prevention and treatment.

7. Experiments on dogs established use of blood plasma instead of whole blood.

C. How is animal experimentation contributing to progress in medicine?
1. Drs. Beard, Halperin, and Lebert at the Chicago Medical School are working on a promising cancer-diagnosis test using rats.
2. An antibiotic known as "LL47" has been able to halt activity of flu virus in mice.
3. Atomic sickness—means of preventing and curing radiation sickness is being conducted on all types of experimental animals.

D. What new developments have been made in surgery through medical research on animals?
1. Development of blue baby operation.
2. Technique developed of replacing diseased bone with steel and plaster.
3. Operational technique for removing a cancerous lung developed on dogs.
4. Brain and heart operations.
5. Blood vessel and bone grafting.
6. Stader splint.
7. Use of plastics in the body in replacing tubes and tissues.

E. What methods are employed in the care of animals used in medical research?
1. Treatment of animals upon arrival.
2. Types of animal quarters.
3. Supervision.
4. Feeding the laboratory animals.
5. Care of animals subjected to surgery.

F. Who are some of the "Health Heroes" in the field of medical research?
1. Edward Jenner 1749–1823; developed the smallpox vaccination in 1796 through experiments with cows.
2. Louis Pasteur 1822–1895—"Father of Microbiology," developed preventive treatment for rabies and anthrax for man and animals.
3. Joseph Lister 1827–1912—first advocate and user of asepsis.
4. Robert Koch 1843–1910—isolated the tuberculosis germ and became the first "microbe-hunter."
5. Paul Ehrlich 1854–1915—pioneered in chemotherapy.
6. The Walter Reed Society and present day health heroes.

- G. From what sources may anyone learn about the use of animals in medical research?
  1. National Society for Medical Research
  2. Illinois Society for Medical Research
- H. How is medical progress hindered?
  1. Lack of sufficient animals.
  2. Antivivisection movement.
  3. Insufficient public awareness.

III. Possible Approaches

- A. Introduction to unit may begin with class discussion of such common diseases as diabetes, measles, polio, rabies, smallpox, diphtheria, or scarlet fever.
- B. Show one or more of the following films to motivate unit:
  "Story of Dr. Jenner," about vaccination.
  "Story of Louis Pasteur," Hydrophobia or Anthrax.
  "They Live Again," about diabetes and discovery of insulin.
  "A Way in the Wilderness," about Goldberger's work on vitamin B.
  "Man's Greatest Friend," about dogs.
  "Triumph Without Drums," about pure food and drugs act.
  1. Informal discussion of some of the great contributions animals have made as illustrated in the films.
- C. Bulletin board exhibit of the ten important killers of American people of the present and of 25 years ago.
- D. Speaker from Illinois Society for Medical Research.
- E. Comic book, "A Medal for Bowser," given to each student to read in class, followed by a discussion or dramatic adaptation of the pamphlet.
- F. Special occasions, as the March of Dimes, Christmas Seals, Crippled Children's Fund and Cancer Fund Drive, are excellent times to stress the importance and continued need for research.

IV. Suggested Activities

- A. If possible have T.B. unit at school for all to have X-ray.
- B. Organize class into committees of two or three members each and have them give oral reports of some of the great men of medical research.
- C. Building of library in classroom by writing to state departments of public health or local branches of national groups such as American Heart Association, Tuberculosis Association, American Cancer Association and the National Society for Medical Research for free materials.
- D. The use of films already mentioned as introduction and also review.

E. Pass out for students' notebooks copies of:
"A Medal for Bowser"
"What To Do—if your dog is lost"
"Caesar Speaks"
"Your Pet and Medical Research"

F. Have class as a committee of the whole, collect pictures and clippings from all available sources for a bulletin board and then a notebook contest on the subject—"Medical Research and My Health."

G. Classroom exhibit of all materials, notebooks, pictures, charts, library collection and live animals for all of school to see.

H. Several students might go to the lower grades and give reports of what they have learned in the unit about animals and health.

I. Guided tour adjusted to grade level of class through one of the experimental laboratories with a lecture by a specialist.

J. Committee to make a chart illustrating the "Reduction of Communicable Diseases" as to the date and the discovery.

K. An all school assembly.

L. Several advanced students might find out what the Nobel Prize is and why it was awarded to Banting in 1923; Professor Tadeus Reichstein of Switzerland; and Drs. Egas Moniz of Portugal and Rudolph Walter Hess of Zurich, Switzerland in 1949.

M. Have students list all possible reasons why the average life span has increased in the past 50 years after they have investigated and studied this thoroughly.

N. Individual listings made by class of all the illnesses they have had during the past 2 years and the drugs or surgery used in restoring health. Ask physician or specialist how many were made possible through animal experimentation.

O. Illinois Society for Medical Research membership cards given to students.

V. Evaluation

A. Quiz program—similar to "20 questions" using "Who Am I" questions about health heroes.

B. Consider quality of individual reports, bulletin board work, notebooks, committee activity of individuals, and level of participation.

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*4. "Your Pet and Medical Research"

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* Available free in quantities; National Society for Medical Research, 208 N. Wells Street, Chicago 6, Illinois.

† Health, Happiness, Success Series.

‡ The Road to Health Series.

USE ANTIBIOTICS ON PLANTS WITH CARE

If antibiotics, such as streptomycin, Terramycin and Chloromycetin, are used on plants to check disease or increase the rate of growth, the one used must be chosen with care in light of new findings by Drs. M. R. S. Iyengar and Robert L. Starkey of the Agricultural Experiment Station and Rutgers University here.

Some of the antibiotics increase the effect of plant hormones, or auxins, they find. Others reverse or block the effects of the auxins.

Terramycin, Chloromycetin and to some extent streptomycin increased the effect of the hormone, for plants, indoleacetic acid, in the tests. The antiauxin effect was shown by citrinin.

SCIENCE DURING THE SCHOLASTIC PERIOD

Anton Postl
Oregon College of Education, Monmouth, Oregon

The span of history between the fall of Rome and the beginning of the Renaissance saw in Western Europe a great decline in scientific endeavor. It is recalled that even the Romans made very few original contributions to scientific knowledge, and Boethius is usually considered the last figure of this earlier Classical Period. Boethius died in 524 which also marks about the beginning of the Dark Ages in Europe, and the torch of learning for the next five or six centuries was kept alive by the peoples of Moslem Culture in the region now included in the Near and Middle East, of which the Arabians were later to influence the Scholastic Period.

The Scholastic Period dates from approximately the eleventh to the sixteenth centuries with the given dates marking the limits rather than the period of its height. The Scholastic Period obtains its name from the attempt to use the powers of the mind as used in logical dialectical discourse and resort to authority as the means of arriving at knowledge. The period is marked for its theological rather than its scientific accomplishments. It is the period in which Aristotelian Logic is used as the tool to establish Christianity on a logical basis. It can, therefore, be looked upon as a neo-Aristotelian period. Gilson (4) states on page 380 that

> It is currently objected against medieval theology that the addition of the Christian grace to the Aristotelian nature rather resembles an attempt to square the circle.

This comment is somewhat understandable when one considers the atmosphere of free thought, at least for the privileged, and what would be called pagan background that was Aristotle's, and the attempt of authoritarian Christianity of this period to build on his foundations. This objection is neatly overcome by Gilson (4) as he writes on the same page

> It is perfectly true that Aristotle's Φυσις (Physis-Nature) is of Necessity shut down on itself, a closed system, and that any attempt to open it up to the divine influence would be altogether unjustifiable. Moreover, God did not create it, it is no work of His; how then should He meddle with its disposal?

This seems to place Aristotle in the rather awkward position of placing him outside God's providence or make him almost equal in authority which is just about what did happen, though neither solution is in accord with Thomistic views, the greatest classic of Scholasticism as will be shown later.

Theology was not only established as a science but it was the

"Queen of the Sciences" while the forerunners of the natural sciences, the pseudo-sciences of astrology, alchemy and magical medicine were intentionally obscured by concentration upon the supernatural and the use of allegory and symbolism. One can readily see that this is not a fertile soil in which the seeds of the search for truth about nature could thrive. The other important fact is that nearly all learning was in the hands of the Church and was carried on mainly in episcopal or monastic schools, and even the palace schools were usually directed by chaplains.

One of the major tasks of the whole Scholastic Period seems to be the resolving of the conflicts between the Hellenic and Latinic Cultures. The Romans had earlier begun translating some of the works of the Greeks and it is known that at the beginning of the Scholastic Period further contact was made with the Greek as well as Hebrew and Arabian philosophers, and interestingly enough contact with the Greek Classics came often through Arabian translations which had already, for example, adapted Aristotle's teachings to their own religious views.

Alcuin, an English Theologian (735–804), is sometimes referred to as the Father of Scholasticism, and his contribution is the reintroduction of the classification of knowledge into seven liberal arts while earlier Varro had distinguished among nine.

John Scotus Erigena, (about 810–880), was one of the last men who still enjoyed comparative freedom of thought and that, very likely, only because he was a native of Ireland where the best learning of the time took place. Also he had a knowledge of Greek which was for his time very unusual, and for this reason he can be considered among the first who infused knowledge of the ancients into the stream of Scholasticism.

Anselm (1033–1109) is often called the true founder of Scholasticism as he was the first real proponent of the unlimited powers of sustained intellectual effort.

Peter Abelard (1070–1142) was a great fearless teacher and critic who also had unending faith in the powers of the dialectical method to resolve all contradictions and to establish the truth. He is famous for his "Sic et Non" method of exposition.

Hugh of St. Victor (c. 1096–1141) was a mystic allegorizer who stated that (1) "all sciences existed in practice before they were reduced to rule." Though the meaning of the term sciences or scientia in those days is by no means the same as our present meaning of the term and philosophy and theology were hard to distinguish, he must have had the present field in mind because he mentioned the interrelations of mathematics, logic and physics and noted that mathematics ignored one or two dimensions and that logic neglected the

properties in their concreteness. In his work "Didascalicon" he distinguishes between the fields of theorica, practica, mechanica and logica. Under mechanica he lists seven arts and crafts which undoubtedly are related to the earlier arts.

John of Salisbury who in 1180 was Bishop of Chartres is notable for two things: first for the change from the cathedral school to the studium generale which was the early developmental phase of what later became the University and secondly he also recognized the need for demonstration work as a method of science. He recognized the existence of errors in Aristotle's work, particularly in natural philosophy, and insisted that the authority of the old authors should not interfere with the exercise of critical reasoning.

Adelard of Bath in the beginning of the 12th century on his travels in Spain learned Arabic which he used to translate Euclid, and he hinted at the use of mathematics for quantitative work in science.

Leonardo of Pisa's "Book of the Abacus" introduced in 1202 the Hindu-Arabic numeral system which is another significant milestone in the history of science that falls into this period.

About this time a new Aristotelian invasion of Western Europe took place, particularly at the University of Paris. Up until then Aristotle was only incompletely known but now new translations from the Greek and many from the Arabic which had been adapted to conform to the teachings of the Koran were being made. Most of these translations were also very literal and non-idiomatic. This extension of Aristotle's teaching was the cause of considerable consternation as can be seen from the papal prohibitions in 1215, in 1231 by Gregory IX, and in 1263 by Urban IV expurgating Aristotle from school use. Nevertheless, by 1255 the course of study of the Faculty of Arts included Physics.

Albertus Magnus (1193–1280) the teacher of Thomas Aquinas, noticed this Arabian influence of Averroes and others. This recognition resulted in adapting Aristotle to contemporary Western Christian thought and a refusal and resulting withdrawal of Moslem and Hebrew influence.

With St. Thomas Aquinas (1225–1274) Scholasticism may be considered to reach its zenith. He was assisted by William of Moerbecke in the translating of Aristotle's works. The main aim and purpose of Aquinas appears to be to utilize Aristotelian logic to justify religious dogma and to make it scholarly and more respectable. In perusing his major works (5) he appears to be unendingly concerned with trivia and as far as natural science, at least, is concerned we have no great contribution. A few statements from his own works will clearly indicate his position. From the work on Aquinas by Pegis (5)

. . . Sacred doctrine is a science because it proceeds from principles made

known by the light of a higher science, namely, the science of God and the blessed.

and the following two quotations from Gilson (4)

Nature is henceforth defined as the order of second causes willed by God. . . .

Thus by throwing the obediental power into a general and divine order we reach a technical definition of the place of miracle in nature.

his fundamental logic may be discerned.

It is, of course, obvious that such basic attitudes have little need of continued searching for the truth as it constitutes a completely self-contained system.

The first thinker of the period whose attitude in some respects is in accord with modern scientific thought is Roger Bacon, an English monk who lived from 1214 to 1294. Though his personality and adherence to superstitions and conflicting theological doctrine would in no way qualify him as a scientist, he nevertheless believed in experimental science, "Scientia Experimentalis,"and the use of mathematics, and he prophesied many coming technological advances.

Don Scotus who died in 1308 might well be considered the last man of this period who made some contribution to scientific thinking by his doctrine of matter in which he distinguished between physical and metaphysical matter, but he also believed in the power of the intellect alone to arrive at the truth.

This, then, ends the period, what might be considered the calm before the storm, because soon men were to arrive who would throw off the multiple shackles of restricting dogma, of acceptance of the former Great as final and sufficient authority, and the belief in dialectical reasoning as the only necessary tool for progress.

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ON TEACHING OF THE SLIDE RULE

R. F. Graesser
University of Arizona, Tucson, Arizona

The following explanation of the log log scales, somewhat amplified, has been used by the writer in his classes. He has not seen it in any slide rule manual that has come to his attention. In what follows N (or M) is any number indicated on a slide rule scale; log N (or log M) is its common logarithm; and ln N (or ln M) is its natural logarithm. The unit of distance on any scale is called its modulus. Thus the modulus of the C scale is the entire length of that scale. The distance from the left index of C to N is the mantissa of N, which only equals the log N if N is a number between one and ten.

The LL1, LL2, LL3 are consecutive parts of the log log scale for numbers greater than one. Together they will be called LL. The modulus of LL is the same as that of C. The left index of LL3 is the zero on LL from which distances are measured positively or negatively, right or left. The distance from this left index to N is log ln N. This index is marked e since log ln e equals zero. To find any power of N, we proceed as follows:

Let

$$x = N^n.$$

Then

$$\ln x = n \ln N,$$

and

$$\log \ln x = \log \ln N + \log n.$$

We then have the simple rule:

To find the log ln *of a power, and hence the power, add the log of the exponent to the log* ln *of the base.*

Example 1. Find

$$x = 1.2^{4.3}.$$

Solution:

$$\log \ln x = \log \ln 1.2 + \log 4.3.$$

Draw the left index of C opposite 1.2 on LL2. Read x equals 2.19 on LL2 opposite 4.3 on C. In applying the above rule, we must be careful to add the log of the exponent, not merely its mantissa.

Example 2. Find

$$x=1.2^{43}.$$

Solution:

$$\log \ln x=\log \ln 1.2+\log 43,$$
$$=\log \ln 1.2+\log 4.3+1.$$

Draw the left index of C opposite 1.2 on LL2. Since the modulus of LL is that of C, we add the one by adding the length of C, thus reading x equals 2550 on LL3 instead of reading the results on LL2 as in *Example 1.*

Example 3.

$$x=1.2^{0.43}.$$

Solution:

$$\log \ln x=\log \ln 1.2+\log 0.43,$$
$$=\log \ln 1.2+\log 4.3-1.$$

We subtract the one by subtracting the length of C, thus reading x equals 1.0815 on LL1. For the first few examples solved, the student may wish to write an equation like the last one above, but he soon learns to carry out the process without such an equation. It is readily seen that $N^{0.1}$, N, and N^{10} are opposite each other on consecutive parts of LL since each is obtained from the preceding by adding the length of C (equals one, equals log 10). The solution of *Example 2* might have been obtained using tenth powers thus:

$$x=1.2^{43}=(1.2^{4.3})^{10}=2.19^{10}=2550.$$

Also we see that the indices of LL1, LL2, and LL3 must represent $e^{0.01}$, $e^{0.1}$, e, e^{10}, for the same reason.

The log log scale for numbers less than one will be called LL0. It may consist of several parts, one above another, like LL. Distances on LL0 represent log $(-\ln M)$. Since ln M is, in this case, negative, we take $-\ln M$ to make log $(-\ln M)$ real. The zero from which these distances are measured is marked 0.368 (equals e^{-1}) since log $(-\ln e^{-1})$ equals zero. However, the same rule for finding powers applies as before because we have:

$$x=M^n,$$
$$\ln x=n \ln M,$$
$$(-\ln x)=n(-\ln M),$$
$$\log(-\ln x)=\log(-\ln M)+\log n.$$

Sometimes LL0 has the modulus of A, sometimes that of C. An index

of one of these latter scales is opposite 0.368 on LL0. Opposite the indices of these scales, we have on LL0 from right to left e^{-10}, e^{-1}, $e^{-0.1}$, etc. Let the distance on LL0 from 0.368 to M equal d. Then:

$$d = \log(-\ln M) = \log \ln M^{-1}.$$

as M decreases, M^{-1} increases, and d increases. Hence, the numbers of LL0 decrease from left to right. Suppose LL and LL0 have the same modulus and e is placed opposite 0.368. Then, if N and M are opposite each other on LL and LL0 respectively, we have:

$$\log \ln N = \log(-\ln M) = \log \ln M^{-1}.$$

Hence,

$$N = M^{-1}$$

so that these scales may be used to obtain reciprocals.

MONSANTO AIDS SCIENTIFIC EDUCATION

An enlarged and strengthened Monsanto Chemical Company program of aid to scientific education, which will benefit 58 American colleges and universities during the 1953–54 school year, was announced today by Dr. Carroll A. Hochwalt, Monsanto vice-president.

More than $275,000 will be spent on the program by the company. The aid program includes scholarships, fellowships, grants-in-aid, contributions for research projects, student and faculty trainees, and donation of equipment and materials.

Monsanto's interest in education also assumes world-wide scope with the inclusion of programs of the British subsidiary, Monsanto Chemicals Limited, and Monsanto Chemicals (Australia) Limited. In England, 16 separate grants for research were set up at the Universities of London, Cambridge, Wales, Birmingham, Bristol, St. Andrews, Leeds, Manchester and Glasgow. The Australian company sponsors research at the Universities of Sydney and Melbourne. Combined expenditure for this program by the overseas subsidiaries will be about $40,000.

Entirely new to the Monsanto program this year are 10 undergraduate scholarships which can be awarded by the administering schools on the basis of both need and merit. Also included in this year's program are 15 fellowships, 18 senior scholarships, 15 grants-in-aid, and four special contributions. The 1952–53 program included 13 fellowships, 17 senior scholarships, and seven grants-in-aid.

In addition to this general program, many Monsanto operating divisions or departments have established fellowships or grants for study in specific fields, in many cases at schools in their geographic territory. Although the majority of the awards are in the fields of either chemistry or chemical engineering; mechanical engineering, biology, and other related sciences also are included.

Fellowships for post-graduate work have an average value of $3,000. Part of this amount goes to the school for the administration of the fellowship, while the larger part goes to the fellow. With the senior scholarships and the new undergraduate awards, the amount is essentially to cover the tuition of the recipient at the respective schools.

In the case of all of the general awards, the selection of the individual recipients has been made entirely by the schools. Choice of fellowship thesis topic has been determined by the schools and individuals concerned.

TIME FOR A CHANGE

Barbara Allen
Minneapolis, Minnesota

Eighty per cent of the young people graduating from our high schools today will not go on to college. Only a few of the remaining twenty per cent choose science as their vocation. Why, then, do we cling so tenaciously to our traditional chemistry courses, neglecting the needs of the majority of our students and even making them antagonistic toward science?

The 1932 study by Wilbur Beauchamp revealed that science teaching is a conglomeration of the orthodox practices of the age of mental discipline (1890–1910) and the newer practices of the two decades preceding the study. While courses in general biology and general science have kept abreast of the newer trends in education, courses in chemistry and physics have clung to the aims of mental discipline, with only a few utilizing the newer practices.

We argue that we must prepare our students for college entrance exams, for their careers in science, for innumerable other distant events which need not dominate the high school. "There is now general agreement that in our democratic American educational system, the secondary school is not the place to train specialists in chemistry, biology, medicine, or agriculture though special aptitude should be discovered and encouraged."[1] Rather, we must concern ourselves with preparing all of our students to live useful, productive lives in a scientific world.

The goal of science courses in general education should not be to equip the student with a vast store of scientific knowledge but rather to give him an understanding of science and its contributons to the intellectual, spiritual, and physical aspects of his life. Thus, a science course in general education should show what science is like, what scientific method is like, and what scientists are like.[2]

This is a big order. Arthur G. Hoff tells us that, "the findings of modern psychology reveal that the majority of the high school population is unable to make effective application and transfer of principles now learned in school. It is necessary, therefore, to make the transfer and application as they are being studied. This can be done most effectively by relating the subject matter to the pupil's environment; that is, build learning experiences around problems vital to the life of the learner." A study by Margery S. Gilson has shown us that chemistry, as taught in high schools today, does not function in the

[1] Wundt, Gerald, "The Role of Science Education in a Democracy," *The Bulletin of the National Association of Secondary-School Principals*, p. 19: Vol. 37, No. 9 (January) 1953.

[2] McGrath, Earl J., ed., *Science in General Education*, William C. Brown, Dubuque, Iowa (1948).

daily life of the pupil mainly because there is not enough correlation between the subject matter and actual living, and because the quantity of factual information required of the pupil is greater than he is able to assimilate functionally.

The picture is not an entirely black one, however. Chemistry courses have progressed to a certain extent. One of the changes exhibited since 1930 is the offering of more courses of study specifically adapted to meet the needs, abilities, and interests of those pupils whose formal education will end with high school graduation. The rise of the chemical industry has also helped to change our traditional chemistry courses; emphasis is, in some cases, now on wise selectivity and away from a wholesale piling up of facts. The textbooks have had a face-lifting too. Rather than giving the pupils large, indigestible chunks of difficult material at the beginning of the course, the psychological approach is being used in which difficult material is distributed throughout the text.[3] Perhaps a few of our most forward-looking teachers have adopted these changes. That the majority have not can be shown by the enrollment figures for science courses from 1910–1949.[4] Enrollment in chemistry has increased from 6.9% to 7.6%, while the enrollment in general biology has increased from 1.1% to 18.4%. We are not giving our students what they need.

Let us look at one alternative to our traditional chemistry courses, an experimental chemistry course tried at the Susan Miller Dorsey High School in California in 1940–42. The students devoted their time to studying various problems such as agriculture, petroleum reserves, and water supply, using as their methods of study reading, discussion, experiments, and trips related to the general problems. In a comparison with other students of the same general ability who had had their chemistry in a regular class, it was found that the students from the experimental classes gained higher marks in their other courses than did the students who had not taken the experimental course. Results on standardized chemistry tests showed that students in the experimental classes gained adequate factual knowledge of technical chemistry. Further, grade-point averages after one year of college showed a slight over-all advantage for the experimental group. A special testing program within the classes themselves showed improvement of students' ideas of the interrelationships between themselves and the environment, increase in desirable social attitudes, increased ability in organizing material and in giving oral and written reports, and development of laboratory and library techniques.[5]

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[3] Jaffe, Bernard, "Trends in High School Chemistry," *The Bulletin of the National Association of Secondary-School Principals*, pp. 67–73: Vol. 37, No. 9 (January) 1953.

[4] Johnson, Philip G., "The Teaching of Science in Public High Schools," p. 21: Bulletin 1950, No. 9, Federal Security Agency.

[5] Laton, Anita D., and Powers, Samuel Ralph, *New Directions in Science Teaching*, McGraw-Hill Book Company Inc. (1949).

Another example of this new type of chemistry course is the classes taught at George Rogers Clark High School in Hammond, Indiana in 1941–42. The classes were closely tied up with the community, studying its problems and its industries. Some of the unusual features of the course were: evening sessions every two weeks at which students presided and at which demonstrations and project-reports were given, joint sessions of the classes held weekly for group discussion, visual aids, etc., and a cooperative program in which the students might substitute two weeks in class for two weeks in the laboratories of various industries in the region. The students continued to rank high on Purdue tests, showing that they had lost no academic ground by participating in the program.[6]

Another alternative to our traditional chemistry courses is a unified course in physical science. After a setback during the war years, physical science courses are again on the increase. This trend seems to be based upon the recognition of the superior possibilities of a composite physical science course over the separate chemistry and physics courses in contributing to the aims of general education, and upon the disposition of many colleges to recognize the physical science course as a bona-fide college entrance unit. Perhaps, the physical science course will supplant our separate chemistry courses, but this should be an event of the distant future. Despite its possibilities, the immediate substitution of physical science for separate chemistry and physics units seems foolhardy. Too few of our present teachers are prepared for multiple-subject science teaching. Many do not have adequate preparation for teaching one science; forcing a unified physical science program upon them would be disasterous to both teacher and student.

"Taught properly science is a flexible, functional inquiry into a fascinating universe of facts, ideas, speculations, discoveries, and conclusions."[7]

Let us look at our history and then at our aims. It *is* time for a change.

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[6] *Ibid.*

[7] Brooks, Harold E., and Woodruff, Clarence H., "The Administrator Looks at Science Education Objectives," *The Bulletin of the National Association of Secondary-School Principals*, p. 12: Vol. 37, No. 9 (January) 1953.

Today in 8,000 communities there are lay citizen committees working on educational problems with local school boards and administrators. In 1950 there were fewer than 1,000 lay citizen groups of this kind known to the National Citizens Commission for the Public Schools.

Every year amateur photographers take enough snapshots to encircle the earth three times.

DEMONSTRATING SIMPLE VALENCE IN HIGH SCHOOL CHEMISTRY

MENHOW M. GUNKLE
Thornton Township High School and Junior College, Harvey, Ill.

Regardless of whether simple valence is thought of as some form of holding power, electrical attractiveness, or filling orbits with electrons, it might be pictured for the beginning student in chemistry from the simple theoretical structures of some of the atoms.

When students are learning a science there must be, in the beginning, seemingly concrete footholds that will assure them of certain steps forward. A device that can be made to present a picture of the term "valence" need not be elaborate, expensive, or time consuming in its construction. The device is not too far from a theoretical picture. The limits of its use can be quickly detected by the instructor. However, the picture of valence that is given to the student is clear and meets limited qualifications. It is not a purely scientific device.

MATERIALS NEEDED FOR CONSTRUCTING THE MODEL

Materials needed are: two pieces of cardboard, 1/16th inch or more in thickness and approximately 14×14 inches square with smooth white surface on one side; large cardboard carton; small cork; small flat-headed nail, about 1 inch long; compass; black ink and small felt brush.

PROCEDURE FOR CONSTRUCTING THE MODEL

Mark one of the cardboards as shown in Figure 1 by using the compass set at radius $5\frac{3}{4}$ inches and draw a circle on the face of the cardboard opposite the white side so the circumference is tangent to both sides of one of the right angles of the square. The side opposite the white surface is used so as to present a finished product that is clean. Draw a second circle of radius $5\frac{1}{2}$ inches, then a third of radius $4\frac{3}{4}$ inches from the same center. Cut the plate on the outer, or third circle from the common center. Now divide the circle so that there are eight equal points of location on the second circle. This can be done by drawing diameters perpendicular to each other then bisecting the right angles. Now at each of the eight division points between the first and second circles from the common center cut out a strip approximately $\frac{1}{4}$ inch by $\frac{3}{4}$ inch with a sharp knife. This will represent a simple structure of an atom that will accept electrons in the outer orbit such as carbon, nitrogen, oxygen, and chlorine. Using the remaining piece of cardboard from which the large circle was cut draw four circles of $1\frac{1}{2}$ inches radius and on each have a flap about $\frac{3}{8}\times1\frac{1}{4}$ inches. The flaps are blackened with ink by the brush. These small

circles are used to represent atoms that exhibit a positive valence of one.

Showing that an atom can accept electrons and how many can be

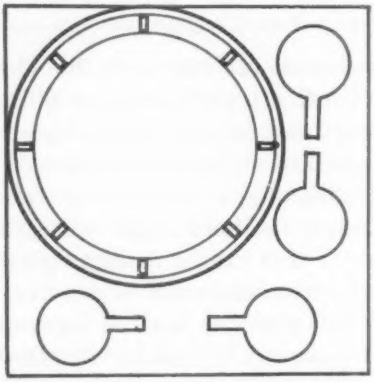

FIG. 1. Diagram of pieces to be cut.

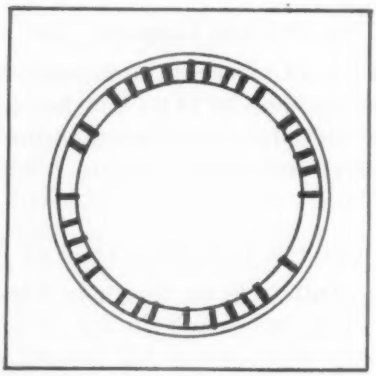

FIG. 2. Diagram of square where ink patches are drawn.

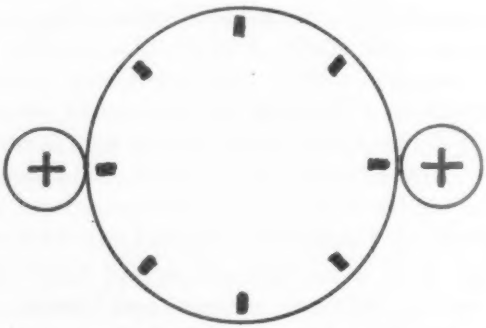

FIG. 3. Assembling the model to represent a molecule consisting of a negative atom with a two-valence and a positive atom of one-valence such as H_2O, Na_2O, H_2S, K_2S, etc.

derived by inked strips on the second uncut cardboard square. Center the "cut-out" or "orbit" plate with white face out on the uncut square and pin the center so that the cut plate can be rotated. At this stage of the model the locations for the inked strips are marked on the uncut square plate. Starting with the element carbon the area behind four of the "cut-out" strips must be blackened, that is, the square plate will have four black patches just a little wider and longer than the "cut-outs" on the round plate. This leaves four blank spaces that represent the outer orbit of the carbon atom as capable of accepting four electrons. The inked strips represent electrons in the outer orbit of the carbon atom. Next, rotate the outer edge of the round plate about $\frac{7}{8}$ of an inch to the right and mark five of the "cut-outs" on the square and black them in—this represents nitrogen as able to accept three electrons. Rotate the round plate another $\frac{7}{8}$ of an inch and mark six "cut-outs" and black them to represent oxygen. Continue the rotating and marking for representatives of chlorine and neon. The striped plate is represented by Figure 2. The model can then be used to show a completely or an incompletely filled orbit of electrons.

Now assemble the two plates with the small nail. It has proved convenient to glue the square plate on the surface of a large cardboard carton and secure the round plate by having the nail inserted through the board into a cork. If the element oxygen is discussed the round plate will be rotated so that six black marks, representing electrons, are showing. Using two of the small circles insert the black flap between the large round plate and the square plate behind the blank space. This now shows that oxygen is able to accept two electrons in its outer or valence orbit and will also show that oxygen should exhibit a negative field as there are two more electrons in the valence orbit. Figure 3 represents this combination of atoms as HOH or H_2O. Oxidation and reduction may be discussed while using the model. The small circles can be used to represent an atom of hydrogen, sodium, potassium, etc. The white band between the black strip and the small circle also gives the effect of the univalent atoms as having a positive field.

This simple model in action has given a picture to those students who are unable to visualize the descriptive material on the term valence and may be of help in explaining the terms "oxidation" and "reduction." It has also been found to aid in the understanding of the terms "complete orbit" and "incomplete orbit."

The assembled model may be used to exhibit a water molecule, sodium oxide, hydrogen sulfide, etc. As was previously stated, the instructor can quickly determine the extent of its use.

ON FLYING SAUCERS AND OTHER "UNUSUAL" AERIAL OBJECTS

Julius Sumner Miller

Ford Foundation Fellow, University of California, Los Angeles

As the year is about to turn (I am writing this on Christmas day) it appears appropriate to look in retrospect on the subject of flying saucers and other things—a matter which has stirred many people both in and out of scientific circles. The daily press and magazines and journals of both good and ill repute have belabored the citizenry with a mixture of "fact" and "fiction." Teachers of *science* at all levels have been put in peculiar positions and a goodly number of inquiries have come to me. Some teachers, I know, have "lost face" by their inability to give their charges a solid reply—and we well know that kids can ask some pretty tough questions. What I propose to do in this article is precisely this: a number of highly reputable men have made some scientific utterances on the subject in reliable technical quarters. A summary of these will convey to the reader the general position now held by scientific observers. Although no *final* opinion has been stated—except by the quacks—the evidence points clearly in one direction, but readers are still free to interpret as their judgment or bias dictates.

Man's history is filled with all sorts of things, mythical and real. This is particularly true of the sky. The earliest written records, such as stone writings, show the sky to be filled with various gods and birds and animals. Indeed, the constellations are just mental constructions of these mythical creatures. Interestingly enough, this mythology abides with us still, and the constellations are taught to beginners in terms of the likenesses conjured up. Now quite apart from this "old" mythology a "new" one has arisen, the outgrowth generally of balloon and airplane observers and air-defense spotters. These reports appear to possess psychological character, however, rather than physical.

The Air Forces have been especially interested in the flying-saucer business, for obvious reasons. A sifting and analysis of the reports shows that roughly some 80% of these observations by reliable, competent observers fall into the following "facts": they are weather balloons; they are planes; they are reflections from objects like newspapers flying about; they are meteors (at night); they are reflections of searchlight beams incident on clouds. So far these *things* are real. *There remains some 20% of utterly reliable reports which have no simple explanation.* What shall we say of these? The position *now* taken in scientific quarters is that these *unexplained mysteries* are atmospheric phenomena such as mirages and fog and ice-crystal layers. Nearly all the "objects" reported by fliers at great heights can be explained on the basis of standard physical concepts. There is one observation, however, that of a hovering nocturnal light, which still does not fall within the description of known physics. Of course, *one way* to get out of this dilemma is to agree that these flying saucer images are craft from interplanetary space manned by men from other planets!

These "unusual" phenomena are really not new to the literature. A recent letter to *Science* (Vol. 116, page 640) refers to reports by Elihu Thomson in 1916 and by John Zeleny in 1932, wherein were described some "objects in the sky."

Finally there remains to be stated another point of view. If these things are not real in the sky and if they are not pure psychological abstractions could they not be spots in the eyes? Indeed, this is how the "canals" on Mars came to be "established"!

This fall the United States was short about 345,000 public elementary and secondary school classrooms. Three classrooms out of every five were overcrowded.

THE CONTENT OF A JUNIOR COLLEGE COURSE IN MATHEMATICS FOR THE PURPOSE OF GENERAL EDUCATION

Lauren G. Woodby
State Teachers College, Mankato, Minn.

The purpose of this investigation[1] was to compile a comprehensive list of subject-matter items from certain terminal courses in mathematics now being offered at the junior college level, and to evaluate these items as to their worth for general education.

The Compilation of the Composite List of Topics

Catalogues from 94 junior colleges and 374 senior colleges were examined to obtain a list of courses in mathematics that met the following criteria:

1. The description must indicate that the course was designed to meet the needs of students who do not specialize in mathematics or its allied fields.
2. The course must be planned for the junior college level.
3. There must be no college mathematics course prerequisite to the course under consideration.
4. The description must indicate that the course is a terminal course in mathematics.

Of the 101 course descriptions that met the criteria, 21 were found in junior college catalogues and 80 in senior college catalogues.

A brief questionnaire was prepared and sent to each of the 101 selected institutions for the primary purpose of ascertaining the sources of the subject-matter topics included in mathematics courses offered for the purpose of general education. Eighty replies were received, and, of these, 18 were eliminated because (1) the institution did not offer the course during 1951–52, (2) the course was considered by the respondent as a preparatory course, or (3) the questionnaire was incompletely filled out. Analysis of the 62 usable replies revealed that:

1. More than half the courses under consideration had been offered for the first time in 1948–49 or later.
2. Eighty-four per cent of the respondents reported that no research investigations or committee reports had been used in selecting the content of the course.
3. Twenty-six different textbooks were reported as basic study materials. Six of these were frequently used, i.e., each of these 6 was reported by at least 4 institutions.

[1] This article is one part of the author's Ph.D. dissertation, "A Synthesis and Evaluation of Subject-Matter Topics in Mathematics for General Education," University of Michigan, 1952.

4. Syllabi or course outlines were received from 17 respondents.

The 17 syllabi were examined to find all the different subject-matter topics therein. Each specific subject-matter topic that was found in the first syllabus examined was copied onto the appropriate one of 8 work sheets that had been labelled as follows: Arithmetic; Algebra; Geometry; Business and Finance; Trigonometry-Analytic Geometry-Calculus; Probability and Statistics; History and Biography; and Miscellaneous. When all the topics in the first syllabus had been listed, the second syllabus was examined and its topics not already listed were added to the work sheets. The same procedure was repeated with each of the remaining syllabi until all the topics occurring in all the syllabi were copied on the work sheets.

Each of the 6 most frequently used textbooks was examined line by line from cover to cover to find the subject-matter topics it contained. Whenever a topic was found that had not been included in the list obtained from the syllabi, it was added at an appropriate place in the outline.

The resulting master list consisted of 570 separate items. It was assumed that these topics provided a sufficiently complete and defensible source of content for courses in mathematics for general education in grades XIII and XIV.

The Evaluation of the Topics by the Jury

The jury consisted of 11 specialists in mathematics[2] known to have an interest in the problem of mathematics for general education at the junior college level and 8 specialists in education[3] known also to have an interest in the same problem.

The following paragaph was included in the letter of instructions sent to each of the judges:

"As a means of achieving a common frame of reference for all members of the

[2] Henry G. Ayre, Western Illinois State College.
J. S. Georges, Wright (Chicago) Junior College.
E. H. C. Hildebrandt, Northwestern University.
Kenneth P. Kidd, University of Florida.
Eugene P. Northrop, University of Chicago.
Charles R. Purdy, San Jose State College.
W. W. Rankin, Duke University.
Luther B. Shetler, Bluffton College.
Robert M. Thrall, University of Michigan
Henry Van Engen, Iowa State Teachers College
James H. Zant, Oklahoma A & M College.

[3] Kenneth E. Brown, U. S. Office of Education.
Howard E. Fehr, Columbia University.
Phillip S. Jones, University of Michigan.
Leonard V. Koos, University of Chicago.
John R. Mayor, University of Wisconsin.
Phillip Peak, Indiana University.
Veryl Schult, Wilson Teachers College.
Henry W. Syer, Boston University.

jury in their evaluations of the items, please assume that you have a son or daughter who:

1. is now a student in a junior college;
2. has primary interests in areas other than mathematics and, therefore, wishes to take only a terminal course in this field;
3. is not preparing for a profession, semi-profession, or vocation that requires specialized training in mathematics;
4. would be benefited by a one-year course called "Mathematics for General Education," the stated objectives of which are:
   a. to provide practice in critical thinking;
   b. to provide the general background and understanding of mathematics that should be possessed by every citizen who completes the fourteenth grade;
   c. to provide training in the skills, knowledges, and processes that are likely to be necessary in the ordinary quantitative aspects of the personal and social lives of all citizens;
   d. to develop interests in, attitudes toward, and appreciations of mathematics in its relation to effective daily living and to other great fields of learning."

A four-point rating scale, described as follows, was placed at the top of the first page of the mimeographed list of the 570 topics.

"Please assign to *every item* a value of "3," "2," "1," or "0" in the space provided, according to the following four-point scale, to indicate your judgment of its value in the course referred to in the accompanying letter:

A rating of "3" indicates your judgment that the item is an essential one for inclusion in the course.

A rating of "2" indicates your judgment that the item is of considerable value but is not an essential item. Items rated "2" could be included as optional topics.

A rating of "1" indicates your judgment that the item is of some value but that it is not important enough to be included in the one-year course.

A rating of "0" indicates your judgment that the item is wholly inappropriate for the course."

The sum of the ratings assigned to each topic by all 19 judges was designated as the index value of that topic indicating its worth for general education. The following table contains the subject-matter topics that received index values of 38 or higher.

TABLE I. THE SUBJECT-MATTER TOPICS IN MATHEMATICS FOR GENERAL EDUCATION AT THE JUNIOR COLLEGE LEVEL ARRANGED IN DESCENDING ORDER OF THEIR INDEX VALUES AS ASSIGNED BY THE 19 JUDGES

Subject-Matter Topics	Index Values
ARITHMETIC	
1. Our number system[1]	57
2. Natural numbers (positive integers)	57
3. Positive-negative numbers	57
4. Common fractions	57

[1] Table I is read thus: The topic in Arithmetic, "Our number system," was rated "3" (essential) by all 19 judges. Its index value, the sum of all its numerical ratings, was 57.

TABLE I—*Continued*

Subject-Matter Topics	Index Values
5. The four fundamental operations with integers	57
6. Exponents	57
7. The four fundamental operations with fractions	56
8. Positive integral exponents	56
9. Laws of exponents	56
10. Decimal fractions	55
11. Reduction of fractions	55
12. Place value in our number system	54
13. The use of zero	54
14. Rational-irrational numbers	54
15. Division by zero undefined	54
16. The four fundamental operations with decimals	54
17. Percentage	54
18. Finding any per cent of a number	54
19. Applications of percentage	54
20. Equivalent fractions	53
21. Comparison of numbers	53
22. Estimation of the result prior to a measurement	53
23. Approximate nature of a measurement	53
24. The number pi	52
25. Square root of a number	52
26. Ratio	52
27. Proportion	52
28. Finding what per cent one number is of another	52
29. Small per cents (less than 1)	51
30. Large per cents (greater than 100)	51
31. Zero as an exponent	51
32. Scientific notation	51
33. Significant figures	51
34. Rounding off numbers	51
35. Comparing numbers by subtraction	50
36. Indirect measurement	50
37. Scale drawings	50
38. Computation with approximate numbers	50
39. Finding a number when a per cent of it is known	49
40. Negative integral exponents	49
41. One to one correspondence	48
42. Units of measure	48
43. Lowest common denominator	47
44. Radicals and roots	47
45. Square root using tables	47
46. Metric system	47
47. Standard units	46
48. Use of measuring instruments	46
49. Accuracy in a measurement	46
50. Rules for operations with approximate data	46
51. Absolute value	45
52. Transcendental numbers	45
53. Absolute error in a measurement	45
54. Relative error in a measurement	45
55. Precision in a measurement	45
56. Proper and improper fractions	45
57. Fractional exponents	45

TABLE I—*Continued*

Subject-Matter Topics	Index Values
58. Cardinal-ordinal numbers	44
59. Denominate numbers	44
60. English system of measure	44
61. Conversion of units within a system	44
62. Direct measurement	44
63. Aids to computation	44
64. Interpolation in a table	43
65. Common logarithms	42
66. Shadow measurements	42
67. Use of ruler, tape, or chain	42
68. Computation using logarithms	42
69. Number systems with other bases (e.g., 5)	40
70. Real-imaginary numbers	40
71. The number "*e*"	40
72. Binary number system (base 2)	39
73. Equivalence relation	39
74. Square root using logarithms	39
75. Square root using approximation-division method	39
76. Computation using a slide rule	39
77. Conversion to units in another system	38
ALGEBRA	
1. The language of algebra (e.g., term, coefficient, trinomial)	57
2. Signed numbers	57
3. Addition and subtraction of signed numbers	57
4. Multiplication and division of signed numbers	57
5. The equation	57
6. Basic terms used in equations (e.g., root, degree)	57
7. First degree equations in one unknown	57
8. Literal numbers	56
9. Monomials	56
10. Graphic representation	55
11. Polynomials	54
12. The function concept	54
13. Basic operations with monomials	53
14. Interpretation of charts and graphs	53
15. Second degree equations in one unknown	53
16. Expression of a function by a graph or a chart	53
17. Expression of a function by a verbal statement	53
18. Expression of a function by a formula or an equation	53
19. Constants	53
20. Addition and subtraction of polynomials	52
21. Systems of first degree equations in two unknowns	52
22. Expression of a function by a table	52
23. Multiplication of binomials	51
24. Function notation	51
25. Dependent variable	51
26. Independent variable	51
27. Variation	51
28. Direct variation	51
29. Inverse variation	51
30. Proportion as an example of variation	51
31. The logic of algebra	50

TABLE I—*Continued*

Subject-Matter Topics	Index Values
32. Construction of basic types of graphs (e.g., bar, circle)	50
33. Arithmetic progression	50
34. Solution of linear systems by elimination or substitution	49
35. Solution of a second degree equation by quadratic formula	49
36. Sequence, progression, series	49
37. Geometric progression	49
38. Simple factoring (e.g., a^2-b^2)	48
39. Algebraic fractions	48
40. Fundamental operations with fractions	48
41. Postulates relative to equality	47
42. Associative, commutative, and distributive laws	47
43. Solution of a quadratic equation by factoring	47
44. Solution of linear systems by graphing	46
45. Solution of a quadratic equation by graphing	44
46. Application of geometric progression to compound interest	44
47. Equations involving fractions	43
48. Combined variation	43
49. The binomial expansion	43
50. Special products (e.g., $[a+b]^2$)	42
51. Solution of a quadratic by completing the square	41
52. Inequalities	41
53. Exponential and logarithmic functions	39
54. Binomial expansion with positive integral exponents only	39
55. Laws of growth and decay	38
GEOMETRY	
1. Deductive and inductive reasoning	57
2. Basic assumptions	56
3. Postulates and axioms	56
4. Definitions	56
5. Undefined terms	56
6. Angles	55
7. Right angles	55
8. The Pythagorean Theorem	55
9. Kinds of angles	54
10. Acute angles	53
11. Obtuse angles	53
12. Non-mathematical reasoning	52
13. The 30°, 60° right triangle	52
14. The 45° right triangle	52
15. Sexagesimal system	51
16. Line and angle relations in a right triangle	51
17. Systems of angular measure	50
18. Similar polygons	50
19. Basic relationships resulting from similarity	50
20. Areas of common plane figures (including trapezoid and circle)	49
21. Volumes of common solids (including pyramid and sphere)	49
22. Symmetry	48
23. Scale drawing as an example of similar polygons	48
24. The 3, 4, 5 right triangle	48
25. The circle and its related parts	48
26. Geometry related to the earth	48
27. Latitude and longitude on the earth	48

TABLE I—*Continued*

Subject-Matter Topics	Index Values
28. Supplementary and complementary angles	47
29. Tangents to a circle	47
30. Vertical angles	46
31. Adjacent angles	46
32. Central angles of a circle	46
33. Use of instruments in geometry	46
34. Use of compass and straight edge	46
35. Angles greater than 360°	45
36. Congruent polygons	45
37. The International Date Line	45
38. Use of a protractor	45
39. Line and angle relations in an equilateral triangle	43
40. Bisection of a line segment using compass and straight edge	43
41. Classification of polygons	43
42. Regular polygons and the circle	43
43. Line and angle relations in an isosceles triangle	42
44. Great and small circles on a sphere	42
45. Bisection of an angle, using compass and straight edge	42
46. Radian	41
47. Construction of a line perpendicular to a given line	41
48. Construction of a line parallel to a given line	41
49. Geometric forms in art	40
50. Angles formed by chords in a circle	40
51. Dihedral angles	39
52. Geometric forms in architecture	39
53. Geometric forms in nature	39
54. Inscribed angles of a circle	39
55. Angles made by sun's rays with the surface of the earth	39
56. Basic geometric designs	38
57. Equivalent polygons	38
58. Line and angle relations in a parallelogram	38
59. Special relations in a rectangle	38
60. Special relations in a square	38
61. Angles formed by secants or tangents	38
BUSINESS AND FINANCE	
1. Simple interest and discount	53
2. Ordinary interest	50
3. Compound interest	49
4. Use of tables to compute compound interest	47
5. Annuities	47
6. Installment buying	46
7. Interest rates involved in installment buying	46
8. Insurance	46
9. Taxation	45
10. Ordinary annuity	45
11. Home ownership	45
12. Life insurance	44
13. Social security	44
14. Income tax	43
15. Automobile insurance	43
16. Sales tax	42
17. Property tax	42

TABLE I—*Continued*

Subject-Matter Topics	Index Values
18. Theory of mutual protection by insurance	42
19. Types of life insurance contracts	42
20. Group insurance plans	42
21. Mortgages	41
22. Indemnity insurance	41
23. Fire insurance	41
24. Profit and loss	40
25. Cash discount	40
26. Money lending agencies	40
27. Budgets, personal and family	39
28. The bank as a loan source	39
29. Interest rates involved in borrowing money	39
30. Finding the cost of an insurance policy	39
31. Computation of life insurance premiums	39
32. Use of the formula to compute compound interest	38
33. Rent of an annuity	38
34. Amount of an annuity	38
35. Unemployment compensation	38
TRIGONOMETRY—ANALYTIC GEOMETRY—CALCULUS	
1. The trigonometric functions	53
2. Solution of right triangles	51
3. Coordinate geometry	51
4. Functions of an acute angle	50
5. Use of trigonometric tables	50
6. Rectangular coordinate system	50
7. Applications involving right triangles	49
8. Standard forms of the equations of a line	49
9. Functions of any angle	47
10. Slope of a line	47
11. Graphs of the trigonometric functions	46
12. Rate of change	46
13. Average rate of change	46
14. Distance between two points	45
15. Functions of special angles (30°, 45°, etc.)	44
16. Equations of the conic sections	44
17. Periodicity of the trigonometric functions	43
18. Equations of a circle	43
19. The derivative	41
20. The limit concept	41
21. Equations of a parabola	40
22. Equations of a ellipse	39
23. Equations of a hyperbola	39
24. Slope of a curve	39
25. Law of sines	39
26. Law of cosines	39
27. Solution of oblique triangles	38
28. Applications involving oblique triangles	38
29. The conic sections	38
30. Tangent to a curve	38
PROBABILITY AND STATISTICS	
1. Arithmetic mean	55

TABLE I—*Continued*

Subject-Matter Topics	Index Values
2. Interpretation of statistical data	54
3. Cautions with respect to interpretation of graphic data	54
4. Measures of central tendency	54
5. Median	53
6. Methods of presenting statistical data	51
7. Deliberate misleading arrangement of graphic data	51
8. Frequency table	50
9. Empirical (a posteriori) probability	49
10. Collection of statistical data	48
11. Mode	48
12. Normal frequency distribution	47
13. Histogram	46
14. Measures of dispersion	46
15. Range	46
16. Permutations	43
17. Combinations	43
18. Normal probability curve	43
19. Frequency polygon	43
20. Frequency curve	43
21. La Placian (a priori) probability	42
22. Percentiles, deciles, and quartiles	42
23. Mortality tables	41
24. Sampling techniques	41
25. Mathematical expectation	38
HISTORY AND BIOGRAPHY	
1. Early numbers	48
2. Hindu-Arabic number system	48
3. Introduction of the zero	48
4. History of the metric system	46
5. Standardization of units of measure	45
6. History of measurement	44
7. History of the U. S. Bureau of Standards	44
8. Greek contributions to abstract geometry	44
9. History of the English system of measure	43
10. History of the measurement of time	42
11. Counting by ancient peoples	41
12. Early developments in geometry	41
13. Early units of measure	41
14. Use of the abacus	40
15. Roman number system	40
16. Origin of our system of angular measure	40
17. Egyptian contributions to practical geometry	39
18. Invention of logarithms	39
19. Relatively recent developments in mathematics	39
20. Origin of common units of linear measure (e.g., rod, fathom)	38
MISCELLANEOUS	
1. The nature of proof	52
2. Mathematics and logic	50
3. Inductive reasoning	50
4. Deductive logic	49
5. The axiomatic method	47

TABLE I—*Concluded*

Subject-Matter Topics	Index Values
6. Syllogism	44
7. Validity	44
8. Truth	44
9. Enrichment material	44
10. Consistency of the axioms in an axiomatic system	40
11. The abstract nature of mathematics	39
12. Independence of the axioms in an axiomatic system	38
13. Uncommon or unusual applications (e.g., LORAN)	38

SUMMARY OF FINDINGS

1. Fourteen topics were unanimously rated "3" (essential) by the 19 judges.
2. Index values of 38 or higher were possessed by 316 of the 570 topics. Thus an average rating of at least "2" (considerable value, but not essential) was assigned to each of these 316 topics.
3. The mean index value was 38.5, and the median index value was 39.
4. Index values of 18 or lower were possessed by 19 topics. Thus an average rating of less than "1" (some value, but not important enough to be included in the one-year course) was assigned to each of these 19 topics.
5. None of the topics was unanimously rated "0" (wholly inappropriate for the course).

A NEW FRESHMAN CURRICULUM AT MIT

A revised curriculum now in effect for entering students at the Massachusetts Institute of Technology was termed "the most important single academic development of the year at M.I.T." by Dr. James R. Killian, Jr., Institute president, in his annual report for 1952–1953 to members of the M.I.T. Corporation.

For the first time in the Institute's history, most freshmen registering this fall have been able to choose one "elective" course, in addition to four subjects and the basic military science (R.O.T.C.) course required of all entering students.

These electives range through many areas of human experience—from spoken languages to theory of numbers. Several "survey courses," intended to introduce students to basic principles in broad areas of scientific interest, are being given for the first time this year under the new curriculum.

Among these are Elementary Meteorology, Perspectives in Life Science, Conservation of Natural Resources, and Earth Science (geology, geophysics, and geochemistry). For example, in the Perspectives in Life Science course, members of the Biology Department cover such subjects as the place of man in the world of living organisms, his adaption to his external environment, and the processes making possible the major functions of his body in health and disease. Conservation of Natural Resources, given in the Department of Civil and Sanitary Engineering, is a "survey of one of the great social problems of modern civilization"; students study the impact of modern technological society—in the development of which, by virtue of their M.I.T. degrees, they are likely to be in the front ranks—on the vital resources by which man lives.

Because silver is a prime ingredient in light-sensitive photo emulsions, Eastman Kodak Company is the second largest individual user of silver in the United States, second only to the U. S. Mint.

THE FIELD TOUR METHOD OF TEACHING BIOLOGY[1]

R. MAURICE MYERS[2]
Biology Department, Western Illinois State College

In recent years Field Tours traveling by bus, train, and boat have become a part of the educational opportunities offered by colleges and universities and secondary schools. They are probably the logical outgrowth of the shorter field trip.[3] The methods used are similar, but since the Field Tour extends for a number of days and covers more territory, many new problems arise and different techniques must be used.

At Western Illinois State College Field Tours were begun over 15 years ago and they have visited by means of busses most of the United States and parts of Canada and Mexico. Others have included Europe, Cuba, and Alaska. Credits have been earned in agriculture, art, biology, geography, music, social science, and visual education. These credits may be used to fulfill a part of the requirements for the bachelor's and master's degrees. These tours have been jointly sponsored by the Western Illinois State College and the Travel Department of the National Education Association.

Instruction in as many as four different fields may be given. Members of the tour receive the benefit of lectures and reports in these fields, but students in each subject matter field work together in groups. Their observations, reports, and summaries emphasize the field in which they receive credit. This organization of subject matter makes it possible for students to obtain a much broader understanding of the area covered.

FIELD TOUR OBJECTIVES IN BIOLOGY

The following are the major objectives for biology and are based on the experiences obtained from more than 24,000 miles of travel on Field Tours that have included all the states west of the Mississippi River, as far south as Acapulco in Mexico and as far north as the Athabasca Glacier in Alberta, Canada.

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[1] A Field Tour is defined as an educational field trip of several days to a month or more covering an extensive area.

[2] The author wishes to make acknowledgements to the following, all of Western Illinois State College: President F. A. Beu, whose continued support and interest including the provision of specially equipped busses have made the Field Tours possible; Mr. A. B. Roberts, Head Visual Education Department and Director of Field Tours who has aided in the development of the techniques described here; Dr. Arthur Tillman, Head of Department of Geography and Geology; Mr. Reece Jones of the same department; and Dr. Mary A. Bennett, former Head of Department of Biology, whose advice and assistance have been invaluable.

[3] Beidleman, R. G., "The field trip—a technique in natural science teaching," SCHOOL SCIENCE AND MATHEMATICS, Vol. 52, pp. 105 to 118, February, 1952. (An excellent discussion of the conventional field trip and includes an extensive list of references.)

1. To observe the plant and animal life of the regions visited.
2. To learn to identify the commonest and most prominent plants and animals; Darwin has written that plants are the most prominent features of the landscape and for this reason every traveler should be a botanist.
3. To observe climatic conditions in each region and make comparisons.
4. To study the ecological relationships of the plants and animals of each region.
5. To study the agriculture of each region and to learn to identify the various crops.
6. To observe the important conservation problems of each area.

Field Tour Techniques for Biology

Before final plans for a tour are completed the tour director and the instructional staff hold conferences to study the region to be covered and decide on the route of the tour and which areas will likely be of greatest interest and of most educational value to students. The tours which have included biology have been made to the western and southwestern United States, Mexico, and the Canadian Rockies and have provided favorable opportunities for biological observations.

The tour directors have developed techniques for handling baggage and other mechanical details, to reduce fatigue, and to maintain the morale of the group. Some of these are similar to those used by Kienholz.[4] Most meals are obtained in restaurants and lodging in hotels except in park areas where cabins are available. Noon meals are often prepared on the bus. Two busses especially equipped for long distance travel are owned by the college and used on most tours. Public address systems are a valuable aid in communicating faculty observations and in presenting student reports while the bus is moving.

Orientation Period.—An orientation period of several days is conducted by the faculty. Usually students assist in the planning of the details of the tour. With the aid of the instructors, maps, and references, the "major points of interest" at which longer stops may be made and places of lesser importance which may be visited are located. Since several different fields are represented it is usually necessary to make some compromises so that each subject matter group will be equally benefited.

Students are assigned to write reports on the major points of biological interest. These are prepared with the aid of the instructor and selected references and include the major units of vegetation, animals, national parks, national forests, museums, problems in conservation and agricultural crops. The reports are edited, revised, condensed, and mimeographed. These are read on the bus to the entire group and the mimeographed copies distributed to each member so that each will have a copy for his notebook.

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[4] Kienholz, R., "Some techniques of a conservation tour," School Science and Mathematics, Vol. 53, pp 363 to 371, May 1953.

Mimeographed maps of each state are provided which give the boundaries of the plant associations. Students color these to correspond to a "master" map and add the route of the tour. These maps aid the student in observing the major units of vegetation and in noting changes. Studies of charts and maps summarizing climate and soils are integrated with these observations and help to emphasize the need to think of animals and plants in terms of broader units and to associate them with environmental factors.

During the orientation period several lectures are given which describe the basic principles of ecology and which emphasize those related to the tour area. An outline of this material is mimeographed and distributed for future reference enroute.

Enroute.—Frequent stops are made. These help to reduce travel fatigue and provide opportunities to collect plants, examine crops, take photographs, and to study conservation problems. The plants

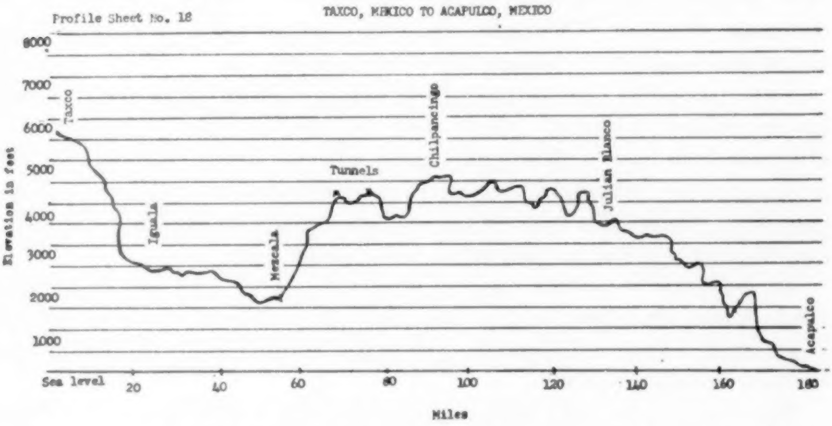

FIG. 1.—One of the profile sheets used on the Field Tour of Mexico. The elevation is given on the vertical axis and miles on the horizontal axis. Prepared by the members of the geography and geology department at Western Illinois State College.

collected are identified by the instructor or by the use of keys and manuals. Students make their own collections and these become a part of a small herbarium which is to contain the characteristic plants of the major ecological units. Even a small dried sprig of mesquite or sagebrush, a few leaves of cotton or of fig provides a tangible record of the tour. And later these specimens may be used to make the study of geography or biology in a classroom much more realistic than words in a book or even a picture. A teacher who "was there," who has actually seen the plants and animals that she describes can speak with greater confidence and command more attention than one who has "just read" about them.

One of the devices that has been of considerable aid is the "profile sheet." These sheets prepared and duplicated by the members of the geography and geology department (see Fig. 1) give the mileage on the horizontal axis and the elevation on the vertical axis. They indicate the location of important cities and towns and other landmarks. These sheets have been very useful in making notes concerning vegetation types.

Wherever possible, local museums are visited. These are useful in describing the animal life of the region and many have excellent displays showing animal life in relation to the vegetation. Such museums as those in Denver, Colorado; San Francisco, California; and Flagstaff, Arizona are excellent in this respect. Many museums have displays showing paleontological evidence for organic evolution. How much more effective as a teaching device it is to see the actual remains of a saber tooth tiger and the "tar pit" from which it came (Los Angeles), a four-toed horse (Rapid City, South Dakota) or a dinosaur (Denver, Colorado) than to depend upon a photograph taken years ago and thousands of miles away!

Some museums should make their displays more easily understood by the visitor, especially those with a time schedule. Some include only scientific names. Many museums, however, provide guide service and a number have guide books. If these are available the instructor can often "brief" the tour group so that the most significant exhibits can be seen and better understood in a short time.

At frequent intervals careful observations of various areas are made while traveling on the bus. For the biologist the changes in vegetation, crops, soil erosion, and other conservation problems are of the greatest interest.

The reports prepared during the orientation period are read to the entire group before a new vegetation unit is entered or before making a stop of biological interest. The public address system greatly improves the presentation of reports. It is interesting to observe how much more significant the reports become when they are given at the place they describe than when they were being prepared in the library, perhaps 2000 miles away! As the reports are mimeographed and given to each student there is no need for making extensive notes. On the spot observations, however make it necessary to make additions to the reports.

Summaries of observations, personal interviews and other sources of information are made daily or when they seem necessary. The instructors from the various fields represented and occasionally students lead the discussions. The most significant features are emphasized during these periods.

To supplement the student reports and observation periods the

instructors call attention to important changes in vegetation and may lead short discussions concerning student observations and answer questions that may arise. Long formal lectures and reports, it has been found, should be avoided, as they may prevent the making of significant observations and defeat their purpose.

At the longer stops, particularly at national parks, educational institutions or museums it is often possible to arrange for lectures by local authorities. Ranger-naturalists may provide descriptions of the national parks and often it is possible to attend evening lectures illustrated with colored slides. Even bus drivers in large cities (e.g. San Francisco) can supply biological information.

A native guide is almost indispensable for travel in Mexico. A well trained and sympathetic guide who can secure the confidence of the rural Mexican and will enable the tour group to see homes, farms, and other places and to obtain information that would be unavailable to the average visitor.

Final Summaries

Students are provided with mimeographed forms that are used to summarize the main biological observations made on the tour. Vegetation types (forests, grassland, desert, etc.), plant formations, principal plant climaxes, their locations, climate, agricultural crops, dominant plants and animals of each climax and conservation problems are included. These summaries are usually made during the latter part of the tour, on the bus, or in a hotel.

After the tour is completed each student submits his notebook, summary sheets, plant collections, and photographs for evaluation. If necessary, additional time is given for the organization of these materials. No formal examinations are given.

Evaluation of Field Tours

While no formal questionnaires have been used, from contacts with students the following educational benefits are claimed for Field Tours in biology:

1. Direct student contact with the various parts of our country which produces a more realistic and lasting understnading of:
   a. The kind of plants and animals in various parts of the world.
   b. The relationships of plants and animals including man to each other.
   c. The kinds of agricultural crops and problems related to their production.
   d. Climate
   e. Conservation problems of different sections of the country.
2. Aids the student to make better observations on personal trips.
3. Improves the teacher's classroom techniques in discussing problems related to the area covered on the tour.
4. Aids teachers to plan trips with their own students. Some of the techniques used can be adapted to trips made by elementary and high school students.

Perhaps the advantages of the Field Tour might be compared to those of a laboratory experience over those of lectures in a classroom.

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Other references have been used, but these are too numerous to list here. Useful free materials and lists of inexpensive publications may be obtained by writing to the superintendents of national parks and the headquarters of national forests (addresses for these may be found in "Trees" listed above), state departments of conservation or education, city chambers of commerce, botany and zoology departments of state universities, state highway departments (official Highway maps), U. S. Conservation District Headquarters (also listed in "Trees") and museums.

During the fiscal year ended June 30, the population increased by an estimated 2,709,000. This figure exceeds the total population in 1950 of Louisiana, Iowa, Washington and Maryland. The monthly rate of increase averages 226,000, more than the population of Syracuse, New York, or almost twice the population of Gary, Indiana's second largest city. The population, as a matter of fact, is increasing at more than twice the rate of 1941. In that year, only 1,280,000 were added to the census rolls.

The largest color photograph transparencies ever made—18 feet high by 60 feet long—are featured at Eastman Kodak's Colorama exhibit in Grand Central Terminal, New York City.

SCHOOL-MADE AUDIO-VISUAL MATERIALS FOR ELEMENTARY SCIENCE CLASSES

HAROLD HAINFELD
Roosevelt School, Union City, N. J.

Secondary science teachers have long had a wealth of non-projectable material for use in the high-school classroom and laboratory. This is one reason why science could be made appealing to students. Demonstrations by the teacher and actual experiments by pupils have proved their effectiveness.

On the other hand, elementary schools have not been constructed with science teaching in mind. There is much to be desired in the 7th or 8th grade, or other classes on the lower level to encourage science teachings. Too many classrooms do not have a sink or gas outlet for burners or outlets for electrical equipment.

The elementary teacher can develop with her pupils, much material that is non-projectable as well as material of a projectable nature. In recent years, the demonstration and experiment have been supplemented by other audio and visual materials of instruction. Many concepts that would be difficult to develop for lack of equipment can now be shown by means of filmstrips, $2'' \times 2''$ slides and 16 mm. motion pictures. Thus a greatly enriched course is possible on the elementary level. By using films, many details can be shown that could not be by demonstrations.

The classroom bulletin board, which has always been of value, now has a wealth of pictorial material available. Recent issues of *Life*, *Look* and *Colliers* has published material that can be used on the elementary level. Students are pleased to bring in pictures and write-ups from newspapers and magazines on subjects being studied. Teachers or pupils can paste these pictures on cardboard or oak-tag and make them into projectable materials for the opaque projector.

The use of student-made models are of value in emphasizing points. Miniature models of deltas and river valleys can be made at little expense. These can be used to show how water has its effect on the soil and erosion. A simple model made from plaster of paris can illustrate most effectively how an active volcano looks. By placing a small amount of *ammonium dichromate* in the crater and igniting it, a very realistic eruption takes place. Such a demonstration by the students is likely to be remembered long after a verbal description will have been forgotten. Papier-mache and clay can be used to make models of animals studied in elementary grades. Pre-historic animals in almost natural settings are possible with these materials.

Lantern slides, both the standard sized $3\frac{1}{4} \times 4$ inch and the miniature 2×2 inch slides can be used to present concepts in an elementary science class. Students can etch the glass for the standard sized lantern slides by rubbing two pieces together with a small amount of valve grinding compound between. They can also be taught to cut the glass to size. An interesting series of slides about star constellations can be produced if the star formations are drawn on white oak-tag or drawing paper with black India ink. These drawings can be photographed with a 35 mm. camera. The illusion of actual stars is produced, as the negative has the white area black, like the night sky, and the black star drawings are white. These negatives can be bound in 2×2 inch binders and be protected by glass wafers by the students and shown to all students during the daytime in the darkened visual-aids room or classroom. Thus, many constellations can be shown to the students during the daylight hours of school when the sun is the only visible star in the sky. The photographically minded teacher can, by using Kodachrome colored film, make a valuable series of 2×2's of various cloud formations to have these available when this unit is discussed in class.

Large charts depicting flower, tree, leaf and seeds are most vital in the study of living things. Our insect and rock collection at Roosevelt has been built mostly through student effort. They look up and identify specimens in insect and rock guides and add their efforts to the collection. The student's name and class are recorded as part of the collection. Many former students return to school to see how these collections have grown since they graduated.

Smelly preservatives and disintegration of specimens can be eliminated when teacher and pupils embed them in thermosetting plastic. This is one of the most popular activities in our upper grade activities. A small oven, made by the students in shop, uses the heat from two 200-watt bulbs to heat the liquid plastic (Castolite or Ward's Bio-Plastic) to a temperature of 120°F., when it hardens. The specimen is then placed in the mold on this clear block of plastic and the process repeated until the specimen is covered. In the shop the mount is polished and any rough spots removed. Each year the 8th-grade pupils embed one or two specimens as part of their science experience.

Of interest as an audio aid are the science broadcasts for elementary school grades now being presented over the educational FM stations. Our school is within range of WNYE-FM, operated by the New York City Board of Education and WBGO-FM, Newark. Schools equipped with wire or tape recorders can save programs of value for future use. Members of the school audio-visual squad record these programs. Thus it is possible for the radio program to be used at any time of the day or year, and the school does not have to juggle the schedule to fit

the time of the broadcasts. We now have 18 of these programs on tape.

Many visual aids can be secured at little expense from various commercial organizations. Most of this material can be retained by the school and used in student projects. Other materials, like 16 mm. sound films and film-strips accompanied by a $33\frac{1}{3}$ r.p.m. transcription may be obtained for postage, but must be returned.

While handicapped by lack of facilities in the classroom, the science or classroom teacher on the elementary level has many projects that can add to a visualized science program and increase the values of the program with pupil participation. Don't overlook some of these possibilities for your students.

NEW PICTURES OF THE MILKY WAY

"We got what we set out to get," University of Wisconsin Astronomer Arthur D. Code, just returned to the Madison campus from South Africa and a six-month study of the structure of the Milky Way, declared. "We do have some pictures now where we 'can see the forest in spite of the trees'."

The Milky Way, observed by the average man, appears as a broad, flat band of light across the night sky, but it is known by the experts to be actually a thin, disc-shaped great cloud of stars with curved arms, a kind of giant pinwheel.

Astronomers have photographed other great spiral systems of stars such as this, but they have been less successful in photographing and interpreting the Milky Way because it is our own galaxy.

"The earth is imbedded in the middle of it," Prof. A. E. Whitford, director of the UW's Washburn Observatory and director of the research, explained last January when Prof. Code and Research Asst. T. E. Houck were readying for the trip to South Africa.

In the Northern Hemisphere, he pointed out, only part of the Milky Way can be seen because the equatorial bulge of the earth hides some of the most vital parts from view. In Africa, however, the team could study this important gap.

Armed with special instruments including photo-electric equipment and a wide angle camera, the UW scientists left Madison last February and "set up shop," 9,000 miles from the home campus: at the Royal Observatory in Capetown, again at the Radcliffe Observatory in Pretoria, and also at Boyden Station at Bloemfontein.

Their object was to learn more about the hub or inner portion of the Milky Way as well as about the outline of the galaxy's spiral structure. (This was an extension of a recent pioneering study in which Wisconsin cooperated and which clearly discerned parts of two spiral arms and located our sun along the edge of one of the parts.)

"Around the neighborhood of the sun, half the matter of our Milky Way is in the form of dust and gas," Prof. Code explained. "The other half consists of stars." The dust and gas was a detriment to good photographs, but with the team's wide-angle camera equipped with infra-red plates, much of the obscuring matter was penetrated.

Charting the outline of the spiral arms was done by measuring the accurate distances from the earth of the blue super-giant stars which occur only along the arms and which are restricted very much to the plane of the galaxy.

"We have the material now to sketch out the arms of our own galaxy," Prof. Code concluded, "but the work won't be ended until all observations are reduced or analyzed." Then he added: "We suspect that on this phase we'll be working for a good number of months."

COMPLEX THOUGHTS

J. M. STEPHENSON
Brown University, Providence, R. I.

I recently came upon a grubby manuscript, my first attempt at original mathematics. At the age of 14, a school friend and I were intrigued by a statement of our math master that the square root of a negative number was "unreal." Since at this age our chief intellectual interests were clairvoyance and spiritualism, we tried to persuade him to expand his remarks on unreality. He admitted that the "unreal" root did have a sign, usually denoted by the letter i, but was unwilling to lead us deeper.

Left to ourselves, and without a mathematical library, we somehow got hold of the idea of drawing the direction of i at right angles to a linear scale of real numbers, thus forming the Argand plane; but we had no knowledge of how to treat a complex variable. Instead, some thought showed that the sign of any direction in the plane could be described as a power of i, thus:

$$ri^2 = -r; ri^3 = -ri; ri^4 = r;$$

and in general

$$z = ri^{2\theta/\pi}$$

This step appeared to open the way to two-dimensional algebra, and in great excitement we took it to our master, thinking that we must have made an important discovery. I am sorry to say that he was quite unable to see what we were getting at, probably because of our incoherent exposition; and it was not until we left school the following year that I learned our "discovery" had been two hundred years too late, and that it is much more useful to write the relation in the form

$$i = e^{i\pi/2} \text{ and } z = re^{i\theta}$$

The inevitable conclusion from re-reading the ink-stained article is that one cannot have access to a library too early in life.

SPINNING WHEEL POWERS NEW SWISS "GYROBUS"

A spinning wheel has become the sole power plant in a new Swiss bus that can zoom along silently at a 30-mile-an-hour clip.

The spinning wheel, however, is a 3,300-pound gyroscope rotor and not the picturesque contraption great-grandmother used to wind cotton, wool and flaxen fibers into thread.

Whirling in its hydrogen-filled cage at 3,000 revolutions a minute, the heavy rotor turns an electric generator that feeds driving motors on the bus' wheels. Once brought up to speed, the rotor will revolve for hours since friction is held to a minimum. But it can power the bus for less than four miles before it has to be "recharged."

To speed the rotor back to a comfortable 3,000 rpm, the motorman drives into a recharging station supplied with commercial three-phase 380-volt electric power. He presses a button and three antenna-like probes rise on the top of the bus to engage the power station's electrical contacts.

In one-half to three minutes, the flywheel again is spinning fast enough to power the bus another three and a half miles at 30 miles an hour.

Built by the Oerlikon Engineering Company, the 50-passenger bus requires no rails or trolley wires, making its initial cost relatively low. "Recharging" stations are inexpensive to build and require little equipment. Passengers enthusiastically report the bus provides a vibrationless, noiseless, odorless ride.

OYSTER LORE

B. Clifford Hendricks
Longview, Washington

"Can you tell me, Sir, is this a live oyster?" The questioner had just returned from a first trip to Hood's Canal "flats" at low tide. He held in his hand what, at first glance, appeared to be an irregularly shaped piece of limestone. The question was addressed to Seabeck's postmaster who had lived at Seabeck or in the Bremerton, Washington area for many years. He took the specimen and after a glance at it replied, "Yes, though not fully ready for the picking."

"Sowing" Oysters

Hood's Canal, an arm of the Pacific and interconnected with Puget Sound, has been used as a testing place for oyster culture. Of the two commercial sorts of oysters the larger and more prolific is the Pacific oyster. Its handicap, in the eyes of the oysterman, is its failure to reproduce itself dependably in Washington state's shore waters. In consequence oyster farmers, of this species, have had to import its "seed" from Japan. Experimentation, however, is encouraging the hope that presently this immigrant oyster may be induced to more successfully produce its own offspring in profitable yields on American shores.

"Sausaging Seed"

Biologists have learned that the presence of limited traces of sperm from the male oyster will stimulate an acceleration of spawning by the female or vice versa. Thus the oyster farmer can, when shore waters reach an optimum temperature, set off a wave of spawning activity by sowing oyster sperm over beds where the females rest. Present practice "triggers" this "wave of spawning" by "grinding up" the oysters in a sort of sausage grinder and spreading the "resulting hash" over the oyster beds. Superficially, it might seem poor economy to thus "hash" thousands of bushels[1] of marketable oysters and then throw them to the tides. "(It) is hard on the oyster," one writer says, "but it may be worth it."

"Dan Cupid" for Oysters

It may be worth it on two counts. Approximately $300,000 worth of Japanese "seed" oysters are imported each year for use by oystermen of the northwest. If the "sausage seeding" is successful a sizable part of that outlay for imports may be saved. A second advantage of

[1] One oyster company processed 8000 bushels of oysters in a period of four days during its "seeding" in 1953.

this artificial spawning is that it helps get the oyster through spawning at an earlier date. Oyster meat, during spawning, is not the high quality it becomes later after fattening. By earlier fattening the oyster farmer has a longer harvest season.

Doctor Jekel and Mrs. Hyde

Mating in oysterland might qualify under, "Believe it or not." The caption above, it should be noted, has it "Doctor Jekel *and* Mrs. Hyde." It is not an *or* as the conjunction. That is intentional for the same individual oyster may be both sexes. "The native, Olympia, oyster may spawn first as a female and then later produce sperm as a male. (The Japanese import, called the Pacific oyster, however, starts parenthood as a young male), but it changes sex as it grows older and ends its life as a female."[2] Thus a sort of Dr. Jekel and Mrs. Hyde blue-print for life.

Grandma Was Wrong

The anatomy of the oyster has been improperly labelled by its consumers. The writer's grandmother never served oysters until she had meticulously removed what she thought was its dark colored stomach. What she pruned away was not the oyster's stomach but its liver. Oyster liver is no more to be feared than that of a beef. The stomach of the oyster, on the other hand, is colorless "and by the time the oyster reaches the consumer no food or other material is within the stomach."[3] Grandma, like some moderns, was "shadow-pruning" something she wasn't removing. Good intentions, negative results.

Oysters' Odds for Survival

"Is this bit of limestone a live oyster?" would seem to be a foolish question. And the answer of, "Yes." should evoke surprise. Then to further imply that the occupant of that stony structure has survival hazards would almost seem to be the height of irony. Even so, the query is in order.

As would be expected, the heavy mortality comes before the stony shell has been formed. In the "fight for survival" the present-day oyster has become a prolific producer of eggs. "A market-sized female oyster may discharge *half a billion eggs* in one season."[4] Such "over production" does not require that "all the resulting larvae" should be caught and grown to market size.

Even after running the gamut of heavy infant mortality and attaining the seeming safety of the stony shell there are still dangers ahead. "Hordes of starfish may sweep across the grounds eating the oysters

[2] Tartar, Vance, *Washington Oysters*, p. 5, Department of Fisheries, Gig Harbor, Washington.
[3] Washington State, *Oyster Culture*, p. 10, Secretary of State, Olympia, Washington.
[4] *Oyster Culture*, *op. cit.*, p. 12.

as they go."[5] The starfish attack the oysters with a poison which relaxes the muscles so the shell opens after which the enemy devours the occupant.

"A species of snail called the oyster drill is more difficult to combat. . . . (They) are able to drill a small round hole in the shell through which they insert a feeding organ and slowly eat the meat."[5] Here it is not that "Fleas have their fleas" but that one crustacean has its enemy crustacean.

Oyster's Offering

If asked, "Why do you eat oysters?" the most probable reply would be, "Because I like them." A pertinent second query might be, "Do oysters like you?" In answer several nutritional assets of the oyster may be listed.

Perhaps, the first to be identified, in point of time, was iodine. An enthusiast might chant, "An oyster a day keeps the goiter away." Even after discounting that statement the oyster is still eligible for enlistment among the preventatives "an ounce of which is equivalent to a pound of cure."

Further "it has been . . . (found) that oysters are highly effective in the treatment of anemia. (Therefore obviously) they will prevent anemia."

"(Also the) copper present in oysters is not stored in the (human) body . . . (yet the oyster copper does) facilitate the elimination of copper from the human . . . which has been obtained from other foods and which . . . might . . . cause diseases such as . . . hardening of the liver."[6] These and other nutrition qualities give support to the oysterman's sales blurb, about "high grade, low cost medical service."

Oyster offerings in other areas of man's living include: lime of their shells for chemical processing; shell chips for chicken grit (to put teeth into chicken gizzards); shell racks as man-made depositories for young oysters after they are ready to "set"; shell pearl for button making and real pearls (at infrequent intervals) which induce the lilt of joy to the eyes of my lady.

No Feeding Yet Fed

When tempted to become an oysterman from the lure of "Here's a crop that requires no feeding," the reader better reread the "ad." This shellfish eats as do all animals. Restated in terms of what to do, it reads "requires no feeding by the farmer." The up-to-the-minute oysterman knows, however, there are two or three factors that alter

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[5] *Oyster Culture*, *op. cit.*, p. 7.

[6] *Oyster Culture*, *op. cit.*, p. 10

the feeding rate of his oyster livestock. The temperature makes a difference; enough so that in cold weather months the oysters may correctly be said to be hibernating. The saltiness of the water needs to be reckoned with. Too much dilution reduces rate of feeding and in consequence reduces both quantity and quality of the oyster harvest. Pollution of the oyster's water habitat, contrary to first inference, does not poison the oyster but starves it. The pollutant destroys the microscopic diatoms that are the major item of the oyster's diet; result, oyster goes mealless. Since the diatom is a single-celled plant the oyster may be said to be a vegetarian. The rhymester[7] puts it

"The oyster is a simple soul
Who sets from tide to tide
Drinking in the diatoms
That flow from side to side."

The Last Round-Up

The western oyster, unlike the western calf at round-up, receives not a brand but is "received," by being canned. Hand-picked at low tide or "tong-dredged" when pickers have to take to their boats at high tide they are dumped into flat bottomed bateaux which in turn, when loaded, are towed to the cannery. Here they are shovelled into a conveyor elevator for the lift to the trays for steaming. This steaming is not for cooking but rather to cause them to open easily. They are "shelled" by use of a special knife. It is said, "a large Pacific oyster . . . can put off (opening by) a clumsy novice for a long time . . . even (if he) uses a pair of pliers. . . . So expert (do these openers become, however) that they can thrust in the knife near the edge of the shell and instantly find the strong connecting muscle; in a second the . . . oyster is in the receiving pail, ordinarily unblemished by the operation. . . . (Those) cut or torn are separately canned and sold as "cuts."[8] After a thorough washing and sorting, as to size, they are then placed in cans, sealed and then into the cooking retort for a half hour of sterilization. After this they are labelled and packed in cartons ready for transport to the markets for consumer purchase. In addition to those canned hundreds of thousands of gallons of oysters are sold or marketed as "fresh" oysters. "The quantity of *frozen* fresh oysters marketed (in 1940) was small."

"The Pacific oyster is indeed a strange creature" as the foregoing account has revealed.

It gets its start in life in Japan,
And ends its travels in a sealed can
On the shelves of some family food closet.

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[7] Griffin, Eldon, *Travels of a Pacific Oyster*, p. 11, Wilberlilla Publishers, Seattle, Washington.
[8] Griffin, Eldon, *op. cit.*, pp. 38–39.

Its welcome in America is growing in volume; its foreign parentage not-withstanding. It is apparently showing signs of becoming biologically naturalized.

TO THE TEACHERS AND SCHOOL CHILDREN OF THE U.S.A.

The International Friendship League at 40 Mt. Vernon Street, Boston, Massachusetts has hundreds of thousands of teacher sponsored letters from boys and girls in all countries of the free world. These boys and girls, in nearly every case, have written in English, and they are all eager to have pen friends in the United States.

Teachers of history, geography, civics, languages and social studies find the letters from abroad helpful in the classrooms, because they contain a wealth of interesting up to the minute information. As a pupil participation project it gives the young people invaluable practice in writing good letters and learning how to express themselves.

The International Friendship League has the endorsement of the Department of State, the National Education Association and the U. S. Office of Education. It is also sponsored by the Ministries of Education in all the free countries of the world.

More than 200,000 American boys and girls are making friends with young people all over the world in this way. They are doing their bit to help better mutual international understanding, and at the same time are getting real enjoyment from their letters from far off countries.

Please send a self-addressed stamped envelope to the International Friendship League, Inc., 40 Mt. Vernon Street, Boston, Massachusetts for information.

TASMANIAN TIGER HUNT TO RESTORE ZOO STOCK

In an effort to replenish the world zoo supply of Tasmanian "tigers," which are rapidly becoming extinct, an expedition headed by Sir Edward Hallstrom, Australian animal hunter, is striking out into the mountains and hidden valleys of Tasmania early in 1954.

Since 1945, tease and bait as they would, zoologists could not lure out these pouched animals from their only present natural habitat in the world on the island of Tasmania. Consequently, all the big zoos have done without Tasmanian tigers.

Known zoologically as Thylacinus cynocephalus, large flesh-eating marsupials (pouch-carrying animals) three feet long including their tails, and about 18 inches high, the animals were widely distributed over the Australian mainland in the early 19th century. Attacks by Australian wild dogs called dingoes and man who wanted to save his sheep from these flesh-eaters greatly reduced their numbers and the only remaining ones were across the channel on Tasmania. There they have taken to the hills and now man is trying to get a few back for the zoos. But these dog-like animals are hard to catch and, too, they are likely to become extinct.

Sir Edward Hallstrom, leading the expedition, is an amateur naturalist, head of a large refrigerating company in Australia and president of Taronga Park Zoological Gardens. He caught an Albino kangaroo, which was presented to President Truman and is now in the National Zoological Park in Washington.

In 1952 the American people helped improve the average salary of the classroom teacher from about $3,240 to $3,400.

WORK EXPERIENCE FOR HIGH SCHOOL SCIENCE MAJORS

CHARLES TOBIAS
Science Teacher, Sewanhaka High School, Floral Park, N. Y.

Vocational preparation has long been stated as an objective of a well-defined program of secondary education. Many science teachers have attempted to meet this need by providing appropriate occupational information related to suitable topics in the course of study. Some teachers have provided opportunities for student laboratory assistants to learn useful skills while rendering a valuable service to the teacher and the school. In classes, students may participate in individual laboratory experiments and work on scientific projects of their own choosing.

More recently, modern educators have come to recognize the value and wisdom of providing actual work experience as a part of the regular high school program of students in selected courses. The opportunity to "learn to work by working" was inaugurated with the cooperation of local business men and industrialists. They welcomed the schools as partners in the tasks of educating, training, and orienting young people to become efficient producers and well-adjusted new employees. Following graduation from high school, many of these students found permanent employment in the industries where they were given their first opportunity to gain work experience.

A survey of current practices in high schools offering work experience programs shows that they are usually limited to those students who are enrolled in the Vocational or Commercial curriculum. Opportunities for student work experiences are usually offered by cooperating owners and/or operators of auto repair shops, electrical and plumbing contractors, business offices, stores, banks, etc. The students combine school with work by spending one week on the job and the next week in classes. By assigning two students to the same job on alternate weeks, a student worker is provided continuously to occupy the position and perform the duties required by the employer. Many students receive wages for the work they do. School coordinators visit the places of student employment periodically to check on pupil progress, as well as to integrate the class work with the practical applications learned on the job.

High schools report considerable success in these programs. Student and teacher reaction has been very favorable. The results can be seen in renewed interest in their other studies and in the improvement in the "holding power" of the high school with fewer students dropping out before graduation. Here lies a possible answer to the dilemma faced by recent high school graduates who find it difficult

to secure employment because they lack experience and who cannot obtain experience because they cannot get a job.

Why shouldn't the advantages of this type of work-study program be extended to students majoring in science? After a student has completed the sequence of courses in General Science, Biology, Chemistry and Physics he has had an opportunity to learn quite a bit about the scientific methods and simple laboratory procedures. He has acquired skills in setting up laboratory apparatus, working with chemicals, making accurate observations, preparing microscope slides, operating a microscope, caring for laboratory animals, etc. Many of these skills can be put to use in local organizations having laboratory facilities for performing work of a scientific nature. A survey of the local community will disclose the presence of such businesses or industries as medical laboratories where urinalyses and blood examinations are made, veterinarian hospitals, bacteriological laboratories, weather observatories, or firms engaged in the manufacture of drugs, plastics, paints, etc. The management will be found willing to cooperate with the high school in setting up the program in your community.

The advantages to the students are numerous. Here is a golden opportunity to make science education functional. Students can see for themselves the application of the theories learned from books. They are in a position to appreciate the role of science in producing things for better living. Close contact with scientists becomes a source of inspiration and guidance. Young people can learn to assume job responsibilities and develop skills and the ability to get along well with fellow-workers.

The school benefits by forging a closer link with industries in the community. Industrial facilities become available resources for the education of students. The educational program and curriculum are thus improved. Fewer drop-outs result as the school discovers additional ways of meeting student needs.

Indeed, the community and the nation as a whole benefit through the educational betterment of the individuals who constitute society. Adoption of this plan may attract young people to scientific work and upon completion of further studies help to relieve the current shortage of skilled scientific manpower.

The largest color photograph transparencies ever made—18 feet high by 60 feet long—are featured at Eastman Kodak's Colorama exhibit in Grand Central Terminal, New York City.

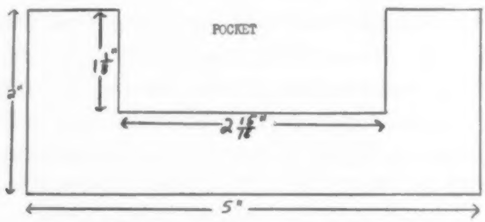
Does your journal reach you regularly? If not, please notify Mr. Ray C. Soliday, P. O. Box 408, Oak Park, Illinois.

USING THE "TWO BY TWO" PROJECTOR AS A MACRO-MICROPROJECTOR

WALTER LENER
State University Teachers College, Geneseo, New York

Teachers often need to project images of objects on microscope slides so that they may be simultaneously viewed by the entire class. While there are a number of excellent microprojection devices on the market, many of them require an absolutely dark room, often produce too high a magnification, and project too small an area of the slide. Furthermore, many schools can not afford to purchase a microprojector.

By utilizing the ordinary "two by two" projector, which is used to project the contents of film strips and 35 mm. slides, and the device described in the following paragraph, the teacher can solve these problems.



MICROSCOPE SLIDE CARRIER

If an extra slide carrier for the projector is available, the slide holding pocket can be machined out so that it will be large enough to retain a standard microscope slide. If an extra carrier is not available, one can be made from easily worked materials such as aluminum[1] or even corrugated cardboard. (*Caution note:* If the carrier is made from cardboard, it should be carefully watched while in use to be certain that the cooling device in the projector is keeping the cardboard well below its kindling temperature.) The new carrier should be five inches long, two inches high, and $\frac{3}{8}''$ thick, with a pocket in the center measuring 2 15/16″ long and $1\frac{1}{8}''$ high, as shown above:

If made from corrugated cardboard, these carriers are cheaply and quickly constructed. Consequently, the teacher may prepare a num-

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[1] If constructed from aluminum, or another easily worked metal, a groove should be made in each of the side walls of the slide pocket so that the slide will be firmly retained within the pocket in a plane parallel to the long axis of the carrier. This can be achieved by reducing the distance between the two side walls from $2\frac{15}{16}''$ to $2\frac{11}{16}''$ and making a groove which extends $\frac{3}{16}''$ into each of the side walls. Thus, the total distance between the left and right groove will be $3\frac{1}{16}''$.

If the carrier is made from corrugated cardboard, it will not be necessary to cut grooves, since the slide will create them as it is slid into the slide pocket.

ber of them, mount one slide in each carrier before projection time, and during projection simply remove the carrier, slide and all, and replace it with a new carrier.

While the resultant magnification is too small to permit detailed examination of microscopic structures, such as cellular contents, it is large enough to permit gross morphological examination of structures such as insect mouth parts, stem cross sections, and other structures which, although visible to the naked eye, require some magnification if they are to be adequately studied.

Furthermore, images projected by this means are visible in a semi-darkened room.

NEW JERSEY SCIENCE TEACHERS ASSOCIATION ANNOUNCE THIRD TELEVISION AWARDS

The New Jersey Science Teachers Association will present certificates of award to those television programs that have presented valuable science material to viewers of New Jersey. Stuart Faber, president of the association and chairman of the Science Department at East Side High School, Newark announced to members at their meeting held at the Haddon-Hall Hotel on Friday, November 13th. The Science teachers are meeting here as part of the New Jersey Education Association's Centennial Convention. Harold Hainfeld, vice-president of the association and teacher at Roosevelt School, Union City again served as chairman of the TV project. He pointed out the increasing role of television in education and the efforts of the association to recognize those programs that present science concepts from pre-school children to adults. The association is also making awards to two closed circuit experiments where the values of television in the classroom are being studied.

1953 Awards of the New Jersey Science Teachers Association are:

Ding Dong School	WNBT	Mon.–Fri.	10:00 A.M.
You Are There	WCBS	Sunday	6:30 P.M.
Meet Me at the Zoo	WCBS	Saturday	1:00 P.M.
To-Day	WNBT	Mon.–Fri.	7:00–9:00 A.M.
Children's Theater	WNBT	Saturday	9:00 A.M.
Ask the Camera	WNBT	Mon.–Fri.	6:30 P.M.
Adventure	WCBS	Sunday	6:00 P.M.
Weatherman	WATV	Mon.–Fri.	6:35 P.M.

Awards to closed circuit telecasts into classrooms to determine the role of television in education are to be presented to

New Jersey Department of Education—Telecasts from Rutgers University to New Brunswick and Highland Park.
U. S. Army Signal Corps—Telecasts at Fort Monmouth, N. J.

The Associations awards have been presented to other TV programs. In 1951 Johns Hopkins Science Review, Nature of Things with Dr. Roy K. Marshall, Mr. Wizard and Zoo Parade received certificates. 1952 programs cited include: Science Lesson, Living Blackboard, Science Is Fun, Mr. I. Magination, The Eclipse of the Sun and the Atom Bomb Test.

Parent-Teacher Associations throughout the country now have 7,953,000 members. This is double their membership of 1946.

IMPROVING PROBLEM SOLVING IN ARITHMETIC

Edgar A. Stahl
Greenwood School, Terre Haute, Indiana

It is always most distressing to hear children heave a long sigh when a thought problems list is assigned. Teachers, too, turn to these lists with trepidation. They also seem to have the feeling that here trouble and confusion begins.

Why is this? There are certainly some valid reasons for such attitudes. Can something be done about it? I feel sure that there can. I am confident that the feeling of uncertainty on the part of students and of helplessness and perplexity on the part of teachers can be changed.

At the root of the trouble, without doubt, is the inability on the part of the pupil to read the problem and understand the situations stated. The pupil seems to have the feeling that these problems may be dashed off, guessed at and solved as are lists of drill problems.

However, we find that they cannot surmount the hurdle of uncertainty concerning the steps to be taken, the processes to be used, their sequences, conclusions to be reached and proof of the solution.

I doubt if this is due to a lack of reading ability. At least, usually, it is not a lack of word calling ability but a more fundamental lack of understanding the situation or situations outlined in the problem.

Now, may something be done about this helpless, hopeless, floundering attitude? An orderly procedure in finding and analyzing the situations presented in the problem, is essential. I believe that authors are not sufficiently careful to outline method and procedure to be followed to accomplish this. Teachers are not agreeable to attack the problem with sufficient care and attention, to effect the ability required. Possibly they are too hurried or just assume that it makes little difference.

Let us consider this problem:

May has 20 yards of ribbon. How many pennants can she make if she needs $1\frac{1}{4}$ yards of ribbon for each pennant? I want the child to read this problem, then re-read it. Now, I want him to do five things: (1) set down in orderly fashion every known fact he can find; (2) write what is to be found; (3) perform the computations; (4) write statements to show that the questions asked in (2) have been satisfactorily answered and (5) prove the problem.

Given: 20 yards of ribbon are to be cut into $1\frac{1}{4}$ yard lengths.
To find: How many $1\frac{1}{4}$ yard lengths can be cut from 20 yards?
Solution: The process used is division.

$$20\text{ yd}\div 1\tfrac{1}{4}\text{ yd}=\frac{20}{1}\div 1\tfrac{1}{4}=\frac{20}{1}\div\frac{5}{4}=\frac{\overset{4}{\cancel{20}}}{1}\times\frac{4}{\cancel{5}}=16.$$

Conclusion: 16 $1\frac{1}{4}$ yard lengths can be cut from a 20 yard length.

Proof:

$$16\times 1\frac{1}{4}=\frac{\cancel{16}^{4}}{1}\times\frac{5}{\cancel{4}}=20. \quad 20\times 1 \text{ yard}=20 \text{ yards.}$$

It is my opinion that every teacher of arithmetic should train her pupils in orderly thinking, so that a list of written problems will be a joy. After all the real value of arithmetic lies in the use we make of it in solving problems which confront us daily.

There is no substitute for clear, logical, orderly thinking and procedure in problem solving.

PHYSICAL SCIENCE SELECTION

A new combination kit of filmstrips entitled "Physical Science Selection" is now being offered by The Jam Handy Organization. This kit was prepared in response to requests from general science teachers for filmstrips answering their particular needs.

The kit consists of a selection of any 15 filmstrips in black and white from a total of 56 filmstrips. Included in the Air Age Physics series of five kits are: "Matter of Molecules," "Mechanics," "Basic Electricity," "Heat," and "Fluids." By selection, the teacher can get a representative group of filmstrips to cover his particular general science course requirements.

The kit, attractively packaged in a book-type container, is especially priced at $60, a saving of $7.50 over the price of the filmstrips purchased individually.

The "Physical Science Selection" kit is available from The Jam Handy Organization School Service Department. It may also be purchased from authorized Jam Handy dealers.

CORTISONE PRODUCED BY MONSANTO

A simplified method for producing cortisone from common chemical raw materials has been developed by Monsanto Chemical Company.

Cortisone, a hormone valuable in the treatment of rheumatoid arthritis, rheumatic fever, allergies and other chronic ills, is now being produced by a complex process from such naturally occurring raw materials as ox bile, which is available only in limited quantities.

In elaborating on the scientific report of the achievement by a four-man research team, Howard K. Nason, research director of the company's Organic Chemicals Division here, said that the new method shows promise of unlimited supplies of cortisone for the first time.

The Monsanto chemists responsible for this accomplishment, under the direction of Oliver J. Weinkauff, associate director of research, include: William S. Knowles, group leader; Lloyd Barkley, Martin W. Farrar and Harold Raffelson.

Nason pointed out, however, that Prof. Robert B. Woodward of Harvard University was the first to achieve a total synthesis of the saturated steroid nucleus, such as is found in cortisone. The Monsanto process starts with an inexpensive, plentiful material. It involves the discovery of new and more practical intermediates as well as the simplification of Woodward's procedure.

To take the biggest flash photo ever made on Kodak color film, 2,400 bulbs were exploded at one time in the famous "Big Room" of Carlsbad Caverns in New Mexico.

PROBLEM DEPARTMENT

Conducted by G. H. Jamison

State Teachers College, Kirksville, Missouri

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

Late Solutions

2353, 5. *Benj. E. Birge, Burdette, N. Y.*

2353, 5; 2361, 3. *Robert Cawley, Dunmore, Pa.*

2361, 2. *Julius H. Hlovaty, New York.*

2361. *John Jones Jr. University of N. C.; Nathanel Grossman, Aurora, Ill.; Leon Bankoff, Los Angeles and the proposer.*

2365. *Proposed by Dwight L. Foster, Florida A & M.*

Show that

$$\frac{1}{2}+\frac{1\cdot 3}{2\cdot 4}\cdot\frac{1}{4}+\frac{1\cdot 3\cdot 5}{2\cdot 4\cdot 6}\cdot\frac{1}{4^2}+\frac{1\cdot 3\cdot 5\cdot 7}{2\cdot 4\cdot 6\cdot 8}\cdot\frac{1}{4^3}+\cdots\frac{4\sqrt{3}}{3}(2-\sqrt{3}).$$

Solution by Leon Bankoff, Los Angeles, Calif.

The series,

$$S=1+\frac{1}{2}\cdot\frac{1}{4}+\frac{1\cdot 3}{2\cdot 4}\cdot\frac{1}{4^2}+\frac{1\cdot 3\cdot 5}{2\cdot 4\cdot 6}\cdot\frac{1}{4}+\cdots$$

is obtained in the expansion of $(1-\frac{1}{4})^{-1/2}$ by the Binomial Theorem, and hence is equal to $(\frac{3}{4})^{-1/2}$, or $(2\sqrt{3})/3$.

Now, the given series is equal to $4(S-1)$, or

$$4\left(\frac{2\sqrt{3}}{3}-1\right),$$

which may be written

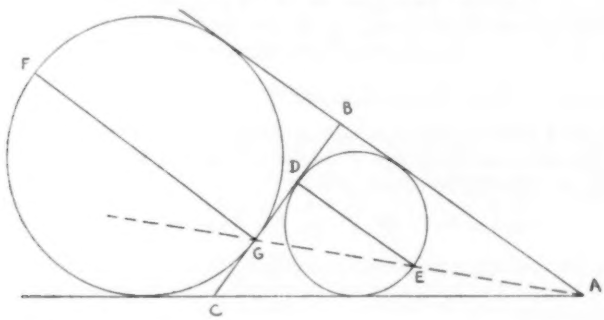
$$\frac{4\sqrt{3}}{3}(2-\sqrt{3}).$$

Solutions were also offered by John Jones Jr., University of N. C.; Lester Moskowitz, N. Y.; Nathaniel Grossman, Aurora, Ill., and proposer Dwight L. Foster.

2366. *Proposed by C. W. Trigg, Los Angeles City College.*

A vertex of a triangle, the point of contact of the ex-circle relative to this vertex with the opposite side, and the remote extremity of the diameter of the in-circle perpendicular to this side are collinear.

Solution by Leon Bankoff, Los Angeles, Calif.



The vertex A of triangle ABC is the intersection of the two common external tangents of the in-circle and the ex-circle and is therefore their external center of similitude.

If side BC touches the in-circle in D and the ex-circle in G, diameters DE and FG are parallel and E and G are corresponding (homologous) points.

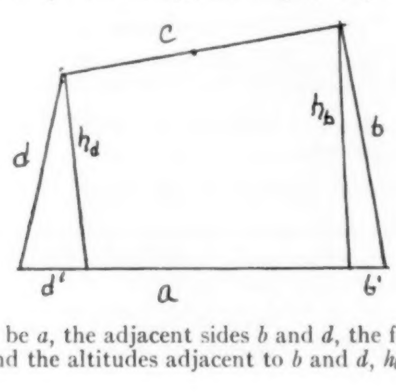
Since homologous points are collinear with the external center of similitude, A, E and G are collinear.

Solutions were also offered by Benj. E. Birge, Burdette, N. Y.; C. W. Trigg, Los Angeles City College; Walter R. Warne, Mt. Pleasant, Ia.; A. R. Haynes, Tacoma, Wash.

2367. *Proposed by Merton T. Goodrich, Keene Teachers College, Keene, N. H.*

Find the formula for the area of any quadrilateral, given the length of one side, the altitudes from the two vertices to this side, and the projections on this side of the two adjacent sides. The given side may be extended if necessary to meet the altitudes and include the projections.

Solution by C. W. Trigg, Los Angeles City College



Let the given side be a, the adjacent sides b and d, the fourth side c, the projections b' and d', and the altitudes adjacent to b and d, h_b and h_d respectively.

Then the area, S, of the quadrilateral is equal to the area of the trapezoid with bases h_b and h_d, plus or minus the areas of the right triangles $bb'h_b$ and $dd'h_d$, according as b' and/or d' fall on a or on a extended. Thus

$$\begin{aligned} S &= \tfrac{1}{2}(h_b+h_d)(a-b'-d')+\tfrac{1}{2}h_bb'+\tfrac{1}{2}h_dd' \\ &= \tfrac{1}{2}\left[a(h_b+h_d)-h_bd'-h_db'\right] \\ &= \tfrac{1}{2}\left[h_b(a-d')+h_d(a-b')\right], \end{aligned}$$

wherein b' and d' are treated as negative quantities if they fall on a extended.

Solutions were also offered by Felix John, Philadelphia; Charles Finnila, Larkspur, Calif.; N. Kessner, Brooklyn; W. R. Warne, Mt. Pleasant, Ia.; Doeris B. Brokaw, Hagerstown, Md.; Leona M. Henry, Shortsville, N. Y., John Jones Jr., University of N. C.; A. R. Haynes, Tacoma, Wash.

2368. *Proposed by Hugo Brandt, Chicago.*

If rectangle $ABCD$ is circumscribed about the ellipse $x^2b^2+y^2a^2=a^2b^2$ and if the points of tangency are S on AB, T on BC, U on CD, and V on DA, show that SV and TU are parallel to diagonal BD.

Solution by C. W. Trigg, Los Angeles City College

Consider the following points on the ellipse, $S(x_1, y_1)$, $T(x_2, y_2)$, $U(-x_1, -y_1)$, and $V(-x_2, -y_2)$. The tangents to the ellipse at these points and the slopes of these tangents are:

$$\begin{aligned} &L_S\colon b^2x_1x+a^2y_1y=a^2b^2 && m_S=-b^2x_1/a^2y_1 \\ &L_T\colon b^2x_2x+a^2y_2y=a^2b^2 && m_T=-b^2x_2/a^2y_2 \\ &L_U\colon b^2x_1x+a^2y_1y=-a^2b^2 && m_U=-b^2x_1/a^2y_1 \\ &L_V\colon b^2x_2x+a^2y_2y=-a^2b^2 && m_V=-b^2x_2/a^2y_2 \end{aligned}$$

Therefore the polygon determined by the intersection of these tangents is a parallelogram.

Now L_S and L_T intersect in

$$B(x_3, y_3)=B\left[\frac{a^2(y_2-y_1)}{(x_1y_2-x_2y_1)}, \frac{b^2(x_1-x_2)}{(x_1y_2-x_2y_1)}\right]$$

and L_U and L_V intersect in $D(-x_3, -y_3)$. Clearly BD passes through the origin and its slope is $b^2(x_1-x_2)/a^2(y_2-y_1)$. The slope of SV and of TU is $(y_1+y_2)/(x_1+x_2)$.

Since (x_1, y_1) and (x_2, y_2) are on the ellipse, we have

$$b^2(x_1^2-x_2^2)+a^2(y_1^2-y_2^2)=0,$$

whereupon

$$b^2(x_1-x_2)/a^2(y_2-y_1)=(y_1+y_2)/(x_1+x_2).$$

Therefore SV and TU are parallel to the diagonal BD and the proposition is true for any circumscribed parallelogram and need not be restricted to a rectangle.

Solutions were also offered by Nathaniel Grossman, Aurora, Ill.; A. R. Haynes, Tacoma, Wash.; and the proposer.

2369. *Proposed by Dewey C. Duncan, E. Los Angeles Jr. College.*

If x and y are unequal rectangular Cartesian coordinates, then $(x+y)/2$ always exceeds $\sqrt{xy}$. If x, y, z are homogenous rectangular Cartesian point coordinates show that

$$\frac{x+y+z}{3}>\sqrt[3]{xyz}.$$

Solution by Cecil B. Read, University of Wichita, Wichita, Kan.

The first statement is merely the statement that the arithmetic mean of two positive numbers exceeds their geometric mean, proved in any standard algebra, such as Chrystal. The statement is meaningless if for example, x is positive and y negative.

The second statement is false, a single example which shows this is $x=y=z=$ unity.

Note: The second statement is true only when x, y, z are unequal positive numbers. If they are equal then an equality exists. Editor

Solutions were also offered by Charles W. Trigg; John Jones, Jr., University of North Carolina; Benj. E. Birge, Burdette, N. Y.

2370. *Proposed by W. B. Goodrich, Dallas.*

An early Texas pioneer staked out his square domain by a rail fence 7 rails high. Each rail 8 feet and 3 inches long touches adjoining rails at centers of supporting posts, stationed along the perimeter 8′3″ from center to center. The number of rails in the fence equals the number of acres in the field. Find the dimensions.

Solution by Julian Braun, Washington, D. C.

Let x be the length of the side in miles. $8'3''=1/640$ of a mile and 1 square mile $=640$ acres. Therefore

$$7\cdot 4x/(1/640)=640x^2,$$

whence

$$x=28 \text{ miles.}$$

Solutions were also offered by W. R. Smith, Suttons Bay, Mich.; John Wicham, Yonkers, N. Y.; C. W. Trigg, Los Angeles City College; Dewey C. Duncan, E. Los Angeles Junior College; W. B. Goodrich, Dallas; Benj. E. Birge, Burdette, N. Y.; Virginia Thayer, Reno, Nev.; Walter R. Warne, Mt. Pleasant, Ia.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

For this issue the Honor Roll appears below.

2369. *Peter W. Markstein, Brooklyn, N. Y.*

PROBLEMS FOR SOLUTION

2383. *Proposed by Leon Bankhead, Los Angeles.*

AB is a quadrant of a circle. Two variable externally tangent circles are tangent internally to the given circle in the extremities A, B, of the quadrant. What is the locus of the center of the circle tangent to all three.

2384. *Proposed by Lewis Clarke, Sodus, N. Y.*

In triangle ABC, if $a:b:c=3:5:6$ show that $R:r=45:16$, where R and r are radii of circum and in-circles respectively.

2385. *Proposed by Bertha Dunning, Canandaigua, N. Y.*

Resolve into factors $a^4(b-c)+b^4(c-a)+c^4(a-b)$.

2386. *Proposed by V. H. Paauet, Milwaukie, Ore.*

Construct a plane triangle ABC given the median, Ma, bisector, ta and difference of $b-c$.

2387. *Proposed by Gloria Dover, Hoosick Falls, N. Y.*

Solve:

$$x^3+y^3+(x+y)^2+x+y=8$$
$$xy=1.$$

2398. *Proposed by Nathan Altshiller-Court, University of Oklahoma.*

The two mediators (that is, perpendicular bisectors) of two sides of a triangle meet those two sides again in two points, and are cut by the third side in two points. Show that the four points lie on a circle.

BOOKS AND PAMPHLETS RECEIVED

Historical Aspects of Organic Evolution, by Philip G. Fothergill, *Lecturer in Botany, King's College, University of Durham.* Cloth Pages xvii+427. 13×21.5 cm. 1953. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $6.00.

The Way of the World. The Rushton Lectures for 1952, by George H. T. Kimble, *Director of the American Geographical Society.* Cloth. Pages x+123. 15×22 cm. 1953. George Grady Press, 541 West 57th Street, New York 19, N. Y. Price $2.50.

Algebra for Problem Solving, Book 2, by Julius Freilich, *Chairman, Mathematics Department, Brooklyn Technical High School, New York;* Simon L. Berman, *Chairman, Mathematics Department, Stuyvesant High School, New York;* and Elsie Parker Johnson, *Formerly Chairman, Mathematics Department, Oak Park and River Forest High School, Oak Park, Illinois.* Cloth. 519 pages. 15×23 cm. 1953. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price $3.20.

An Introduction to the History of Mathematics, by Howard Eves, *Professor of Mathematics, State University of New York.* Cloth. Pages xv+422. 14.5×23 cm. 1953. Rinehart and Company, Inc., 232 Madison Avenue, New York 16, N. Y. Price $6.00.

Plane Trigonometry with Four-Place Tables, Second Edition, by Arthur W. Weeks, *The Phillips Exeter Academy,* and H. Gray Funkhouser, *The Phillips Exeter Academy.* Cloth. Pages viii+197+37. 14.5×23 cm. 1953. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y. Price $2.88, without tables $2.68.

Your Trip into Space, by Lynn Poole, *Producer of The Johns Hopkins TV Science Review.* Cloth. 224 pages. 13.5×20 cm. 1953. Whittlesey House, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $2.75.

Miss Pickerell Goes Undersea, by Ellen MacGregor. Cloth. 128 pages. 13.5×20.5 cm. 1953. Whittlesey House, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $2.25.

MACHINES THAT BUILT AMERICA, by Roger Burlingame. Cloth. 214 pages. 13×20.5 cm. 1953. Harcourt, Brace and Company, 383 Madison Avenue, New York 17, N. Y. Price $3.50.

WAYS OF MAMMALS, by Clifford B. Moore, *Director, Forest Park Museum, Springfield, Massachusetts.* Cloth. Pages xi+273. 13×20.5 cm. 1953. The Ronald Press Company, 15 East 26th Street, New York 10, N. Y. Price $3.50.

ASTROLOGY AND ALCHEMY; TWO FOSSIL SCIENCES, by Mark Graubard, *University of Minnesota.* Cloth. Pages xi+382. 14.5×22.5 cm. 1953. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $5.00.

FLIGHT TODAY AND TOMORROW, by Margaret O. Hyde. Cloth. 140 pages. 13.5×20.5 cm. 1953. Whittlesey House, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $2.50.

A TIME FOR SLEEP, by Millicent Selsam. Cloth. 55 pages. 16×19.5 cm. 1953. William R. Scott, Inc., 8 West 13th Street, New York 11, N. Y. Price $2.00.

FAST IS NOT A LADYBUG, by Miriam Schlein. Cloth. 33 pages. 20×20 cm. 1953. William R. Scott, Inc., 8 West 13th Street, New York 11, N. Y. Price $1.75.

TEACHING ARITHMETIC IN THE MODERN SCHOOL, No. 2, by Vincent J. Glennon with Doris L. McLennan and Students. Paper. Pages x+139. 14.5×23 cm. 1953. Bureau of School Service, School of Education, Syracuse University, Syracuse 10, N. Y. Price $2.00.

FREE COURSES OF STUDY AVAILABLE TO TEACHERS AND SCHOOLS. A DIRECTORY OF 186 GUIDES, by Patrick Carr. Paper. 17 pages. 22×28 cm. Patrick Carr, 607 South Spruce Street, Villa Grove, Ill. Price 50 cents.

BOOK REVIEWS

EARTH SCIENCE, Third Edition, by Gustav L. Fletcher, *Former Chairman, Department of Physical Science, James Monroe High School, New York City,* and Caleb Wroe Wolfe, *Chairman, Department of Geology, Boston University.* Cloth. Pages viii+556. 22.8×17.8 cm. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $3.60.

Anyone interested in a high school text providing material for one semester in earth science and one semester in meteorology should examine *Earth Science,* Third Edition.

The authors have produced a very attractive and useful book. The language of this edition is excellently written in clear and concise sentences that are interesting to read and easy to use in the classroom. The latest available data has been used in making the textual material and illustrations up-to-date.

Much of the illustrative material in this Third Edition has been placed in a two inch center margin on each page. This arrangement adds to the attractiveness of the figures, pictures, diagrams and charts.

The first 18 chapters comprise a study of the land. Among the topics are: rocks and minerals, weathering, erosion, rivers, glaciers, and movements of the earth's crust. Chapter 18, entitled "Stories In Stone," is a very good short history of the earth from the viewpoint of geologists. There are four chapters on the study of the earth in relation to other bodies in space. Eight chapters provide up-to-date materials in meteorology. Following this are three chapters on the sea, and a new chapter on "Conservation of Our Resources."

Provisions for review include a completion summary and a list of questions at

the end of each chapter. At the end of the book is a general review. This review is based on the New York State Regents' examinations.

The laboratory manual accompanying the book contains practical, interesting exercises, and a set of reproductions of Government topographic maps.

ESTIL B. VAN DORN
George Washington High School
Indianapolis, Indiana

HOW TO KNOW THE SPIDERS, by B. J. Kaston, *Professor of Biology, Teachers College of Connecticut;* and Elizabeth Kaston. Paper. 220 pages. 14.5×21.5 cm. 1953. Wm. C. Brown Company, Dubuque, Iowa. Price $2.75.

This is one of the Picture-Key Nature Series which was initiated a few years ago by H. E. Jaques. Professor Jaques has continued to direct their publication so that they now range in coverage through most of the plants and animals with which students are likely to come into contact or in which they might develop a consuming interest.

Spiders certainly rank high among the animal types about which teachers are asked questions, but heretofore there has been little assistance which a biology teacher could give such students. General identification texts on spiders have been few and not recent enough to be reliable, and so students with an interest in spiders were generally shuffled to some other subject in the field of biology or switched their attentions themselves.

But here's a book which helps to solve that problem. The book consists largely of a simple and copiously illustrated key to the spiders, with adequate introductory material to assist the beginner in learning how to key his catches with relative ease. There is also information on how and where to catch them and on the best ways of keeping them in a collection.

GEORGE S. FICHTER
Oxford, Ohio

GENERAL BIOLOGY, by Leslie A. Kenoyer, *Head, Department of Biology, Western Michigan College;* Henry N. Goddard, *Late Professor of Biology, Western Michigan College;* and Dwight D. Miller, *Associate Professor of Zoology, University of Nebraska.* Cloth. Pages viii + 662. 15×23.5 cm. 1953. Harper and Brothers, New York. Price $6.00.

This is the third edition of a long-popular and widely used biology text, this 1953 release incorporating the many new advances made in the field of biology during the eight years which have passed since the release of the second edition. A considerable portion of the text has been completely rewritten—the chapters on cells and cell propagation, physical and chemical aspects of living things, metabolism, genetics, ecology, conservation, and evolution. New illustrations have been added here and there, and the text was reorganized. As in earlier editions, the stress of the material and its presentation is on biological principles, with the plant and animal types used as examples.

For those who are unfamiliar with earlier editions, each chapter is concluded with a group of suggested exercises, and the book contains a comprehensive glossary. There are nearly 450 illustrations, which are well selected and positioned to be companions to the text material.

There are many good high school biology texts which an instructor should examine to determine which best fits his needs, and this text certainly might be the one which is finally selected.

GEORGE S. FICHTER

PLANT MORPHOLOGY, by Arthur W. Haupt, *Professor of Botany, University of California.* Cloth. Pages ix+464. 15×22.5 cm. 1953. McGraw-Hill Book Company, Inc., New York. Price $8.00.

This is a textbook for the advanced student of botany—for the student who has previously learned the basic information and who is now prepared to study

in greater detail the structure, reproduction, and development of higher plants. The text is organized so that it traces evolution in the plant kingdom, from the most simplified plant structures to the most complex; and it is, of course, completely up-to-date in its coverage. Many of the numerous illustrations are published for the first time in this volume. Also, there is a comprehensive glossary, a list of references for further study, and a complete indexing of the contents.

GEORGE S. FICHTER

A HUNDRED YEARS OF BIOLOGY, by Ben Dawes, D.Sc., *Reader in Zoology, King's College, University of London.* Cloth. 429 pages. 1952. $5.00. Gerald Duckworth & Co. Ltd. 3 Henrietta Street, London, W.C. 2.

To any student of biology interested in present day developments, or in the past, here is a book with a wealth of materials not found in the textbook, but the kind of information that can add materially to a better understanding of biology. The author has presented a readable picture by sketching a historical background of the main trends of biological development with a filling of biological facts and ideas.

The interesting historical presentation gives credit to those having contributed to our present concepts. Many of the references are little known but what was contributed has inspired others to investigate still further. Many of us in the United States are prone to forget that much of the history of biological developments came from other countries. The work of Biologists of the British Isles is emphasized but there are also included other references.

In the back of the book 33 pages are devoted to listing of literature referred to in the nineteen chapters, under the title of each chapter.

Here is a book that can be used as a source of reference and as reading to supplement research or for a better understanding of the historical approach to Biology. The high school teacher of biology should find this book useful.

NELSON L. LOWRY
Arlington Heights High School
Arlington Heights, Illinois

HEALTH AND PHYSICAL FITNESS, Second edition, by Florence L. Meridith, *Late Professor of Hygiene and Public Health, Tufts College*, Leslie W. Irwin, *Professor of Health Education, Boston University*, Wesley M. Staton, *Associate Professor of Health and Physical Education, University of Florida.* Cloth. 339 pages. 1953. $3.20. D. C. Heath and Company, Boston.

The new edition of *Health and Fitness* includes many scientific developments which are significant to health and hygiene. Such scientific advances include a study of antibiotics and medical care, sodium fluoride and its relation to dentistry, the new method of artificial respiration, narcotics, psychosomatics, and immunizing techniques. Such material provides practical and basic knowledge which enables the student to understand himself and to develop an appreciation of the sciences.

In addition to being up to date in content the book is rich in student appeal. Its vocabulary and illustrations are suited to the secondary student to such a degree that he should be able to read current reading material with keen interest and understanding.

MARTHA CRAIG
Arlington Heights High School
Arlington Heights, Illinois

PLANE GEOMETRY: A CLEAR THINKING APPROACH, Third Edition, by Leroy H. Schnell, *State Teachers College, Indiana, Pennsylvania*, and Mildred G. Crawford, *Roosevelt School, Michigan State Normal College, Ypsilanti, Michigan.* Pages xii+436. 15.5 cm.×23 cm. Cloth. McGraw-Hill Book Company, Inc., New York. Price $3.20.

This new edition carries *Plane Geometry* as the main topic in its title, and

therefore the title more nearly describes the real purpose of the text. The approach throughout is directed to the pupil and emphasizes the need for understanding, hard work and persistence. The methods used and the approach to problem solving hold a prominent place in the text. Theorems, corollaries and propositions are not distinguished. They are all presented on three levels of difficulty for the pupil's study: the first level with very few hints or helps, the second with more helps and the third level has many problems almost completely solved. Through discussion the student is encouraged to proceed as far as he can by his own initiative. Only when he is completely blocked should he go to the lower level where more helps are given. The organization is not conventional but logical order is maintained.

Reference is frequently made to kinds of work other geometry classes have done. Everyday reasoning problems follow types of reasoning used in geometric situations. Throughout the text appropriate review material in arithmetic and algebra is provided. Where it is feasible experimentation with geometric figures is suggested. The text is well indexed and much use is made of cross references and referrals. Three dimensional geometry is introduced through the concept of adding a dimension. This material is only to present the concept, and point out the relationships. The text presents many problems for the student to solve and more than adequately covers all the material found in the more common types of geometry texts. Several other interesting features are: first, the discussion of how geometry has or has not helped you develop the power of reasoning; second, the use of syllogisms; third, the excellent development of converses, inverses and contrapositives; fourth, the views into new fields of other geometries, the fourth dimension and calculus.

The reviewer feels this text provides a very healthful approach to geometry and if taught well will go a long way toward making plane geometry the invigorating, dynamic and pleasant study it should be.

PHILIP PEAK
Indiana University
Bloomington, Indiana

PRINCIPLES OF MATHEMATICAL ANALYSIS, by Walter Rudin, *Department of Mathematics, University of Rochester*. Cloth. Pages ix+227. 15.5×23 cm. 1953. McGraw Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. Price $5.00.

This is a text planned for a first course in analysis, on the advanced undergraduate or first year graduate level. The treatment is largely traditional, and the book seems well fitted for its objective. The final chapter, dealing with the Lebesgue theory, could be omitted if desired, but many will welcome this treatment.

The reader opening the book at random will be puzzled by the notation. Fortunately, the author has included a list of symbols and abbreviations. There is a very brief bibliography, and a reasonably adequate set of problems. The book is definitely one to be considered as a text; it might well be a good source of information to the teacher or student of elementary courses, who is bothered by the recurring phrase "it can be proved" whenever a concept seems a little mature or involved.

CECIL B. READ
University of Wichita

ANALYTIC GEOMETRY AND CALCULUS, by Lloyd L. Smail, Ph.D., *Professor of Mathematics, Lehigh University*. Cloth. Pages xiv+644+lxx. 15×22 cm. Appleton-Century-Crofts, Inc., New York, N. Y. 1953. Price $5.50.

This is a textbook following recent trends in offering a combined course in analytic geometry and calculus. Calculus is introduced very early in the text, starting, as is common, with the differentiation and integration of algebraic

functions. To the traditional sequence, this book comes as a shock, for example, second degree curves such as the circle, ellipse, parabola, are treated following a considerable portion of work in calculus. It may be more logical, however, to cover solid analytic geometry in a brief treatment of some forty pages just prior to taking up work in partial differentiation and multiple integration.

In general, the coverage is somewhat more complete in calculus, and less complete in analytical geometry, than in current separate texts. There is no discussion of evolutes and involutes; there is a fairly complete chapter on elementary differential equations. There are several topics where the discussion could be omitted without any difficulty in continuity; the range of such topics is somewhat broad, as indicated by listing several: multiple roots of polynomial equations, maxima and minima where $f'(x)\neq 0$, rotation of axes, discussion of the general second degree equation, projectiles, calculation of logarithms, the directional derivative, triple integrals in spherical coordinates.

A considerable amount of material is stated without proof, generally, but not always, there is reference to a source where proof may be found. In some sections the number of exercises seems too few, in other places it is all right. A reference to the index reveals the peculiar fact that "coordinate axes" are only defined for three dimensions; there is no discussion of oblique coordinates.

The author is careful to state conditions under which theorems or formulas do or do not hold; he likewise clarifies points at which the student is likely to make an error (i.e., in the damped vibration curve the maximum and minimum points are to the left of the points of contact with the boundary curves). At a few points this rigor seems to have been lost—in using Newton's method there is no way of telling when an approximation is "sufficiently close"; it is not pointed out that one may encounter alternative definitions for the principal values of some of the inverse trigonometric functions; it is not stated that the rectangular equation obtained by eliminating the parameter from a set of parametric equations may not represent the same curve.

There are the usual numerical tables; answers are provided to the odd numbered problems. Certainly this text merits consideration if one is teaching this combined course. As always with a new type of course, there is difficulty if there is any appreciable number of students transferring to or from schools having separate courses in the subjects.

CECIL B. READ

ELEMENTS OF THE DIFFERENTIAL AND INTEGRAL CALCULUS, REVISED EDITION, by William Anthony Granville, Ph.D. LL.D., *Formerly President of Gettysburg College*, with the editorial cooperation of Percey F. Smith, Ph.D., *Yale University*. Cloth. Pages xv+463. 16.4×23.5 cm. 1911 (reprinted 1952.) Ginn and Company, Boston. Price $4.00.

What might be termed "the older generation" of teachers know of the very wide spread use of Granville's Calculus. Some have gone so far as to say that with each successive revision the quality of the text deteriorated. Whether or not this be true, these teachers will welcome the reprinting of the "original Granville" (the 1911 edition).

It would be presumption on the part of any reviewer to criticize a text which has been proved by the acid test of time. To the younger teacher one can merely say: "Do not fail to examine this classic text." The order of topics covers differential calculus completely then takes up integral calculus. In both parts the coverage is much more complete than in most texts published recently.

The typography is good, occasionally the thin paper allows material on the other side of the page to show through.

CECIL B. READ

ATOMS, MEN AND GOD, by Paul E. Sabine. Cloth. Pages x+226. 14.0×22.2 cm. 1953. Philosophical Library, New York. Price $3.75.

It is increasingly the practice to issue Annual Reviews of various aspects of

natural science. This volume might be, in a sense, considered an assessment of the current status of science as related to religion from a scientist's point of view.

Dr. Sabine merits a hearing by reason of a worthy record of achievement in the field of his specialty, physics. His concern to interpret religion stems from "a childhood in the home of a pioneer Methodist preacher. . . . (The) heritage (from that home) was and is something not lightly to be cast aside." He considers that "In every field of thought the last fifty years have seen a shift of outlook . . . both profound and far reaching. . . . (Since a) most profound shift has come in scientific thought . . . (he proposes to help) an equal shift (that) is . . . due to come in religious thinking." Put briefly, he proposes to explore the query, "Can I be intellectually honest while holding my inherited religious beliefs and at the same time accept the teachings of modern science and psychology about the nature of the world and man?"

In his judgement, "The picture of the material universe as a running-down machine (is) as obsolete as the pre-Copernican system of astronomy. The modern view," he says, "presents the world as a continuing evolutionary process not to be interpreted in static terms of being but in dynamic terms of becoming." (There is evidence for believing that) the stuff of the world is both physical and psychical. . . . (Such a) mind-matter (approach)," he thinks, "(does) not depart from the recognized scientific method of thinking. . . . (By this means he seeks) to get (a synthesis) . . . of the God-centered world of the Christian faith and the world of the electrical wave-particles. (Such a synthesis would), he believes, "give an added dimension to both the religious and the scientific pictures of a final reality."

A glance at his table of contents gives a better over-all perspective of his pattern of treatment. The first two chapters consider "Common ground" and "Common origin" of science and religion; a third "The world as a machine" (and the limitations of such a picture); chapter four, "Life in a running-down world" (evolution, however, contradicts running-down-ness); followed by "Magnetism, electricity and light" (a trinity made one by Maxwell and Einstein); a sixth chapter, "The new physics: matter and energy, a scientific unity; and seven, "The inner world of psychology" (Is man a robot of behaviorism or the victim of the sub-conscious?) and finally "Christianity and human evolution" (Is religion natural or revealed?)

As to method of procedure, Dr. Sabine considers that "integrating synthesis" has been creditably productive in the hands of the scientist as a means of resolving apparent contradictions such as: the wave vs. particle theories of radiant energy; the behavior vs. the sub-conscious theories of psychology and the mechanistic vs. the vitalistic theories of biology. He therefore uses the same method in trying to unify the concepts of those who hold to "revealed" religion and those who embrace the philosophy of a "natural" religion. The reviewer found this approach both stimulating and rewarding. He had previously had a session with philosopher Shimer's "Conscious Clay" and after this study of Sabine's "psychic-matter" it occurred to him that "I'd like to read the 'synthesis' of an informed theolog upon this topic."

B. CLIFFORD HENDRICKS
Longview, Washington

TEXTBOOK OF BOTANY, Revised Edition: By E. N. Transeau, *Emeritus Professor of Botany, Ohio State University*, H. C. Sampson, *Professor of Botany, and Plant Pathology, Ohio State University*, and L. H. Tiffany, *Professor of Botany, Northwestern University*. Cloth. pages xi+817. 1953. Harper and Brothers, New York. Price $6.00.

The new edition of *Textbook of Botany* should be welcomed by instructors and students alike. It departs from the usual sudden plunge into morphology and taxonomy by starting with stress on the importance of man's welfare from an ecological study of botany. The first chapter deals with the importance of plant sciences and the purpose of studying botany. Study of plant parts precedes study-

ing of classification, followed by an insight of seasonal aspects of plants. This pattern of introducing that which is familiar to the student before that which is new avoids the usual confusion and bewilderment often apparent in the beginning student. The material is written in an accurate scientific manner that is not dull; rather, interesting and fascinating. Photographs and diagrams are plentiful, well chosen and used effectively for a better understanding of textual material. A complete index is augmented with additional references listed on the end of each chapter.

It is encouraging to see a college text written in the lighter of modern trends of science education instead of the classical standard of merely stating facts unrelated, dull, and cold.

NORMA PETEFISH
Arlington Heights High School
Arlington Heights, Illinois

SYNCHROS, SELF-SYNCHRONOUS DEVICES AND ELECTRICAL SERVO-MECHANISMS, by Leonard R. Crow, *Educational Specialist in Design and Development of Training Aids for Teaching Electricity, and Director of Research and Development, Universal Scientific Company*. Cloth. Pages x+222, 13.5 by 21.5 cm. The Scientific Book Publishing Company, Vincennes, Indiana, 1953.

The author's purpose stated in this book is "to contribute a broad understanding of the basic fundamental principles underlying the functional operating theory as well as the effective use and applications of synchros and allied self-synchronous electrical mechanisms." The book is designed "for use in colleges, technical schools and training courses for the armed forces, as well as needed information for engineers and technicians. . . . "

The use and operating principles of synchros as position indicators, generator-control transformers and differential devices are discussed. The theory and uses of magnesyns and other saturable-core electrical servo-mechanisms are treated. D.C. operated servo systems are also considered.

Detailed laboratory directions for six experiments with synchro devices are included. The directions refer specifically to units of apparatus included in the author's Universal Rotating Electrical Machinery Kit.

The text is liberally illustrated with many clear and well-drawn schematic circuit diagrams and with cut-away line and half-tone drawings of the different machines under discussion.

WALTER G. MARBURGER
Western Michigan College of Education
Kalamazoo, Michigan

BASIC IDEAS OF MATHEMATICS, by Francis G. Lankford, Jr., *University of Virginia*, and John R. Clark, *Teachers College, Columbia University*. Cloth. Pages viii plus 504. $15\frac{1}{2}$ by $22\frac{1}{2}$ cm. 1953. World Book Company, Yonkers-on-Hudson, New York. Price $2.84.

This basic text in general mathematics, incorporating revisions and adaptations of selected materials developed jointly with Raleigh Schorling (late of the University of Michigan), is an excellent text for use on the ninth grade level. Those teachers who have used the Schorling and Clark text—*Mathematics in Life*—will find this text a definite improvement in organization and content. Emphasis is given throughout to the practical uses of mathematics in everyday affairs—in commerce, business, and community and personal living. The content of the text is shown by the following chapter titles: life in mid-twentieth century, fractions in measurement, decimals in measurement, on to geometry, construction and design, the use of per cents, mathematics and daily living, putting your savings to work, how to picture number relations, introduction to algebra, putting algebra to work, formulas of geometry, measuring by means of triangles, and mathematics on the job.

Major attention is given to the concepts, skills, and social applications of arithmetic. Six of the fourteen units of the text are devoted to review and extension of these important mathematical tools. Content of the units devoted to algebra and geometry is limited to the practical aspects of these subjects that are recognized as essential to general mathematics "literacy." Common types of graphic representation are treated in terms of the student's everyday experiences with newspapers and sales literature.

The excellent presentation gives opportunities for a wide range of sensory experience, experimentation, and discussion. Mathematical meanings are given major emphasis. A consistent program of motivation, understandings, purposeful practice, and evaluation is provided throughout the text. The list of "key words to know and use correctly" is of help to the student as is the "hints for locating troublesome spots." The tests and reviews at the end of each chapter are very good.

The general appearance of the printed page is good. The diagrams and the illustrative materials add to the appearance as well as to the usefulness of the text.

T. E. RINE
Illinois State Normal University
Normal, Illinois

THE TEACHING OF SECONDARY MATHEMATICS, by Claude H. Brown, *Professor of Mathematics, Central Missouri State College.* Cloth. Pages xi plus 388. 14½ by 21½ cm. 1953. Harper and Brothers, 49 East 33rd Street, New York 16, New York. Price $4.00.

This book will find its greatest value as a textbook for prospective teachers of secondary school mathematics; however, it is of great value to the experienced teacher, particularly in regard to the analysis of the place and function of mathematics in a program of democratic secondary education.

Part I, the Nature and Role of Secondary School Mathematics, deals with a discussion of why teach mathematics, the historical background of today's curriculum, educational theories and the teaching of mathematics, and the place of mathematics in secondary education. Part II deals with specific teaching problems in secondary mathematics. In this part of the text there are chapters that deal specifically with demonstrative geometry, elementary algebra, ninth grade general mathematics, and such other courses as advanced algebra, trigonometry, and solid geometry. Part III considers the professional preparation of teachers of secondary mathematics. This includes not only the philosophical basis but also the specific preparation essential for competence in teaching secondary mathematics.

There are many fine features of the text. These include that part of the text dealing with the historical background of the mathematics curriculum, the place of mathematics in secondary education, the reading difficulties of mathematics, and the discussion on the teaching techniques in the particular subject-matter courses of the secondary mathematics program. Also this includes a very good discussion of the various phases of mathematics as a mode of thinking. The attention to detail in regard to specific ways of solving typical problems of the classroom is of particular help to the beginning teacher.

The text does not give the beginning teacher a depth of insight into the place of secondary mathematics in the total structure of mathematics. The author does point out the place of mathematics in secondary education in a very excellent manner.

The style of writing is interesting and easy to read. The ideas are presented clearly and thoroughly. The author recognizes that the teacher of secondary mathematics must have a broad knowledge of subject-matter and should recognize how learning takes place in order to be a successful teacher.

T. E. RINE

BABIES FOR CHILDLESS COUPLES

WATSON DAVIS
Director, Science Service

About 10,000 children in America, most of them not more than 15 years old, are the products of artificial insemination, born to marriages which greatly desire children although the husband does not have the fertility to father children.

In most of these cases, no one except the married couples knows that the actual physiological father of the children is a quite anonymous donor, a young male who never meets the mother and never knows whether children are produced.

This is the application to human beings of the breeding by artificial insemination that has brought about a revolution in stock breeding in the last few decades. In the case of cattle, pigs, etc., sperm of choice male animals is shipped all over the globe. One male can have progeny by the thousands.

Human artificial insemination has not reached such proportions. In the larger cities it is available where medical skill developed over about a decade serves an urgent human need.

The childless couples who seek this route to children are made happy. They love their children in many cases even more than husbands and wives who do not need an unknown donor who furnishes his hereditary material.

Dr. Sophia J. Kleegman, clinical professor of obstetrics and gynecology at the New York University College of Medicine, reported to the recent First World Congress on Fertility and Sterility her medical experience in helping to bring about over 75 successful pregnancies by what she calls therapeutic donor insemination.

BIG POWERHOUSE TO SERVE CANADIAN ALUMINUM PLANT

Giant electrical contacts on huge circuit breakers are scheduled to snap shut in April, 1954, putting the world's largest private hydroelectric plant "on the line."

Created in what is believed the largest underground powerhouse in the world, the electric power will be fed to the Aluminum Company of Canada's new aluminum reduction works 50 miles away at Kitimat, B.C.

The big power plant is situated on the Kemano River 500 miles from Vancouver and 185 miles from Prince Rupert. It ultimately will develop 2,400,000 horsepower for the aluminum company.

Powerful turbogenerators will be turned by water falling 2,585 feet to their blades. The water will be stored in a reservoir 125 miles long.

F. W. Lawton, power expert with Aluminum Laboratories Ltd., Montreal, told the American Institute of Electrical Engineers here today that the hydroelectric power will be transmitted to the smelting facilities at 300 kilovolts—an uncommonly high voltage. He said these will be the first 300 kv cables in North America.

The cables themselves are said to be unique: they consist of the world's largest steel-reinforced aluminum conductors.

Magnifying lenses have been created for welders who wear bifocal glasses. The lenses fit standard protective helmets and are inserted between the regular helmet filter lens and the rear cover plate. The magnifying element of ordinary bifocal glasses usually is out of the line of vision when the helmet is in working position.

A NEW BOOK ON UHF

UHF Television Antennas and Converters, by Allan Lytel, is a forthcoming publication of John F. Rider Publisher, Inc., 480 Canal St., New York 13, N. Y. It is scheduled for publication in late September or early October.

All the latest and up-to-the-minute information on ultra high frequency television antennas, transmission lines, converters and tuners are included.

Numerous diagrams, performance charts and photographs of all types of UHF television antennas now on the market, facilitate the technician's job of selection. What transmission lines to use, when to use them and how they operate both as an antenna lead-in and circuit element, are completely explained.

All types of UHF television converter circuits are broken down stage by stage with schematic diagrams. The purpose, function and layout of each stage is discussed. Complete coverage is given to all commercially used UHF converters including single-channel and full band types. Match-box units and UHF conversion strips are fully treated in the section on single-channel converters.

UHF all-channel tuners are discussed by the various types now commercially available. Circuit diagrams materially aid in the explanations.

This is a valuable reference source for the technician now engaged in installing receivers in UHF areas, as well as the technician who is looking forward to future operations in this field.

New maps show physical features of the U. S. and world much as they would appear in color aerial photographs taken from somewhere in space. These accurate maps can be obtained with state boundaries, capitals and major cities indicated. They are printed on tough paper for framing, or on a plastic-like paper for heavy roll-up duty in classrooms.

CONCRETE IMPROVES WITH AGE

Well-cured concretes and mortars, like wine or cheese, definitely improve with age.

Now in their 43rd year in the University of Wisconsin College of Engineering, hundred-year tests on the strength of concrete have so far revealed that some concrete and mortar mixes, unlike many other material things, increase considerably in strength with age.

Under present plans, the long-time tests on the curing and aging strengths of concretes and mortars on Wisconsin's engineering campus will continue until the year 2023.

Among the first to be initiated in America, these Wisconsin tests are credited with giving engineers early reliable information.

The tests show that over the first 43 years, concrete stored outside, where it is subject to all kinds of Wisconsin weather, becomes more than three times stronger than it was during the first days of its hardening away back before World War I.

The Wisconsin tests are watched with great interest by construction firms of all kinds—road, bridge, and building—since they are of considerable value in both public and private construction involving use of concrete or mortar.

Dean Morton O. Withey of the College of Engineering inaugurated the tests at UW in 1910, five years after he came to the University in 1905 as an instructor in mechanics and in the Materials Testing Laboratory. Reaching the automatic retirement age of 70 at the end of this year, Dean Withey brings to a close nearly half a century of service in Wisconsin engineering education and research.

For the curing and aging strength tests, Dean Withey explains that the concrete mixes were made into cylinders six inches in diameter and 12 inches high for compression tests. The mortars were made into two inch cubes for compression tests and briquets for tensile or "pulling" tests. Three series of tests were begun, one in each of the years 1910, 1923, and 1937.

Different mixes were used such as a "neat" mix, 1:1 and 1:3, and 1:2:4, 1:3:6 mixes. Translated, the "neat" mix consists of pure cement and water; the 1:1 mortar mix of 1 part cement to 1 part sand; the 1:3 mix containing proportions in that order; the 1:2:4 concrete mix consists of 1 part cement to 2 parts sand and 4 parts crushed stone, with the 1:3:6 mix containing proportions in that order.

The products have been curing and aging under these conditions: outdoors, in a cellar, and indoors in water.

Under the tests, the compressive strengths of concrete increased when cured unprotected outdoors in the Wisconsin climate; while cured indoors at lower humidities the strengths decreased after three months.

Although the outdoor exposure was not the most severe, the data from the tests so far completed show that the concretes and mortars of usual proportions had very good weathering qualities.

Dean Withey's tests are now widely credited with giving the engineering profession reliable information about concrete and mortar strengths years after placement. This information is of great importance in estimating maintenance, depreciation, and replacement costs over the years in all kinds of concrete and mortar construction work, Dean Withey is the author of several score bulletins, papers, and reports on his studies in masonry materials.

Adhesive balm is sprayed on the skin directly from the can before adhesive tape or plaster casts are applied. The balm is said to form a highly antiseptic non-toxic, plastic-like film that allows dressings to hold more firmly yet be easily removed.

A CHART ON OUTBOARD MOTORS

Science and shop teachers may obtain, without cost or obligation, a wall chart containing a large-scale cut-away drawing that shows how an outboard motor operates, it was announced today by Hugo Biersach of Evinrude Motors, oldest and one of the largest makers of outboards in the country.

Biersach said a number of teachers who had seen the chart in the stores of Evinrude dealers have written to the company asking for extra copies for use in their classrooms. As a result it was decided to make them available to shop and science teachers in all parts of the country, to aid them in explaining the operation of the millions of small two-cycle internal combustion engines in use today for propelling boats and for many other purposes.

The chart measures approximately 37 inches wide by 49 inches high and is attractively lithographed in four colors on heavy paper. The cross section diagram showing the working parts of a typical outboard motor is amply large for classroom use, being more than three feet high. An operating manual, with detailed information on the operation of the motor, is sent with the chart for the guidance of teachers using it.

Requests for the charts, indicating the number wanted and the use to which they will be put, should be addressed to Evinrude Motors, 4143 North 27th St., Milwaukee, Wis.

A NEW RESEARCH GROUP LEADER FOR MONSANTO

The appointment of Dr. James A. Kapnicky to research group leader in charge of the pilot plant at the Nitro, W. Va., laboratories of Monsanto Chemical Company's Organic Chemicals Division was announced today by H. K. Nason, director of research. The appointment is effective January 1.

Kapnicky, a native of Morgantown, W. Va., joined Monsanto at Nitro in January, 1952, as research section leader following employment by the Dow Chemical Company as research project leader. He served as an officer in the United States Army during the period 1943–1946.

He is a graduate of West Virginia University with a B.S. degree in chemical engineering (1943) and a Ph.D. degree (1950). Kapnicky is a member of the American Institute of Chemical Engineers and Sigma Xi.

GIRLS READY FOR SCHOOL EARLIER THAN BOYS

Little boys should be six months older when they start to school than little girls.

Tests of school children indicate that girls mature that much sooner than boys, Dr. Frank R. Pauly, director of research of the Tulsa, Okla., public schools, told the meeting of the American Association for the Advancement of Science.

In the sixth grade the girls are still ahead. Although two months younger than the boys in the class, they scored six months ahead of the boys on arithmetic and as much as a year and a half ahead on language. It is not until the first year of college that the boys mature enough to catch up with the girls.

If the boys were admitted to school six months later, Dr. Pauly told the meeting, it would not only be better for the boys' schooling, but it would save about two percent on the cost of education over the nation.

There would also be less heartache to boys and their parents due to poor report cards and fewer boys would drop out of high school because of unsatisfactory work, Dr. Pauly said.

TV line-splitter permits homeowners to attach from two to four television sets to a single roof-top antenna. No bigger than a pack of cigarettes, the line-splitter can be obtained to work on 75- or 300-ohm antenna lead-ins.

MATERIALS ENGINEERING—FROM STOVE IRON TO HIPERSIL

Stove iron, paper, silk, and shellac—these were the materials of the electrical industry in its infancy. And for good reason. First, they were the only materials available; and second, neither manufacturers or suppliers yet realized the tremendous importance that materials were to play in the industry's development.

Today, the electrical industry uses a whole host of special materials, plus sizable quantities of more standard materials. Hipersil, Micarta, Fosterite, and a flock of others were developed for their magnetic or electrical properties. This has been no chance occurrence. It has been the result of intensive research, coupled with thorough development. And much of this has been done by the electrical manufacturers themselves.

The situation of the electrical industry with respect to materials has been unique. While physical properties—tensile strength, hardness, resistance to the elements—are of primary importance to most manufacturers, the electrical manufacturer has another complete set of supplementary requirements—electrical characteristics. Reduced to its simplest terms, this has meant that the electrical industry has, to a large degree, had to develop its own materials.

Although each operating division of Westinghouse has its own materials engineers, who not only test the materials bought and used by their division, but also develop new materials specifically for the use of their own plants, much of the development of materials is done by a central organization—Materials Engineering—which serves the whole company. The variety and scope of problems tackled by this department are tremendous. This is occasioned by the innumerable materials of all kinds used by the electrical industry, and by the innumerable different ways in which it uses them.

First of all, Materials Engineering maintains and operates a full complement of physical and chemical testing laboratories, in which it tests most of the thousands of kinds of materials used by the company. In this manner it provides technical assistance and serves as a consulting organization to the Purchasing Department, to design engineers, and to the operating divisions that use the materials. But the major activity of the department is in the development and application of new materials. This phase of its activity is far from being strictly a laboratory procedure. The basic idea often originates in the Research Laboratories. Then Materials Engineering takes over. Laboratory investigations are made, manufacturing techniques are studied, methods of fabrication planned, standard procedures worked out, and, finally—in many cases—a pilot-plant operation established. The products of this pilot manufacture are sold to operating divisions, and in some cases to outside manufacturers, before the process is finally transferred to the appropriate division.

Drinking fount for cattle maintains outdoor drinking water at the desired temperature even in sub-zero weather. Thermostatically controlled, the heated water is prevented from overflowing its basin by a float valve. The "standard" fount works on regular 115-volt electric power, but a 230-volt model is available.

Paint mixer for stores produces the exact shade of paint or pigmented stain selected by the customer from nearly 150 samples. Using one or more of 12 concentrated colors, the machine automatically mixes them with a base paint, completing the job in about 90 seconds. Easy to operate, the machine works on standard electric current.

The Girl Scouts was founded March 12, 1912.

Joseph von Fraunhofer was born March 6, 1787 at Straubing, Bavaria

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